Université de Montréal

Essays on Business Taxation

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à mes parents Passaramzanga B. Simporé et feu Zouba A. Zeida

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Résumé

Cette thèse explore les effets macroéconomiques et distributionnels de la taxation dans l'économie américaine. Les trois premiers chapitres prennent en considération l'interaction entre l'entrepreneuriat et la distribution de richesse tandis que le dernier discute l'arbitrage du mode de financement d'une diminution d'impôt sur les sociétés sous la contrainte de neutralité fiscale pour le gouvernement.

Spécifiquement, le chapitre 1 en utilisant les données du Panel Study of Income Dynamics (PSID) , fournit des évidences selon lesquelles le capital humain ou l'expérience entrepreneuriale est quantitativement important pour expliquer les disparités de revenu et de richesse entre les individus au cours de leur cycle de vie. Pour saisir ces tendances, je considère le modèle d'entrepreneuriat de Cagetti et De Nardi (2006), modifié pour prendre en compte la dynamique du cycle de vie. J'introduis également l'accumulation de l'experience entrepreneuriale, laquelle rend les entrepreneurs plus productifs. Je calibre ensuite deux versions du modèle (avec et sans accumulation d'expérience d'entreprise) en fonction des mêmes données américaines. Les résultats montrent que le modèle avec accumulation d'expérience réplique le mieux les données.

La question de recherche du chapitre 2 est opportune à la réforme fiscale récente adoptée aux États-Unis, laquelle est un changement majeur du code fiscal depuis la loi de réforme fiscale de 1986. Le Tax Cuts and Jobs Act (TCJA) voté en décembre 2017 a significativement changé la manière dont le revenu d'affaires est imposé aux États-Unis. Je considère alors le modèle d'équilibre général dynamique avec choix d'occupations développé au Chapitre 1 pour une évaluation quantitative des effets macroéconomiques du TCJA, tant dans le court terme que dans le long terme. Le TCJA est modélisé selon ses trois provisions clés : un nouveau taux de déduction de 20% pour les firmes non-incorporées, une baisse du taux fiscal statutaire pour sociétés incorporées de 35% à 21% et la réduction de 39.6% à 37% du taux marginal supérieur pour les individus. Je trouve que l'économie connait un taux de croissance du PIB de 0.90% sur une fenêtre fiscale de dix ans et le stock de capital en moyenne augmente de 2.12%. Ces résultats sont consistants aux évaluations faites par le Congressional Budget Office et le Joint Committee on

Taxation. Avec des provisions provisoires, le TCJA génère une réduction dans l'inégalité de la richesse et celle du revenu mais l'opposé se réalise une fois que les provisions sont faites permanentes. Dans les deux scénarios, la population subit une perte de bien-être et exprime un faible soutien.

Le chapitre 3 répond à la question normative: *Les entrepreneurs devraient-ils être imposés différemment?* Par conséquent, j'analyse quantitativement la désirabilité d'une taxation basée sur l'occupation dans un modèle à générations imbriquées avec entrepreneuriat et une prise en compte explicite des cohortes transitionnelles. La reforme principale étudiée est le passage d'une taxation progressive fédérale identique tant pour les revenus du travail que pour le bénéfice d'entreprise au niveau individuel à un régime fiscal différentiel où le profit d'affaires fait face à un taux d'imposition proportionnel pendant que le revenu du travail est toujours soumis au code de taxation progressive. Je trouve qu'une taxe proportionnelle de 40% imposée aux entrepreneurs est optimale. Plus généralement, je montre que le taux d'imposition optimal varie entre 15% et 50%, augmentant avec l'aversion du planificateur pour les inégalités et diminuant avec son évaluation relative du bien-être des générations futures.

Dans le contexte de la réforme fiscalité des entreprises, le chapitre 4 évalue les compromis de neutralité fiscale de revenu dans le financement d'une réduction de l'impôt des sociétés. Pour respecter la neutralité fiscale, le gouvernement utilise trois instruments pour équilibrer son budget, à savoir l'impôt sur le revenu du travail, les dividendes et les gains en capital. Je construis ensuite un modèle d'équilibre général parcimonieux pour obtenir des multiplicateurs budgétaires équilibrés associés à une réforme de l'impôt sur les sociétés. En utilisant un calibration standard de l'économie américaine, je montre que les multiplicateurs liés à l'impôt sur le revenu du travail et l'impôt sur les dividendes sont négatifs, suggérant ainsi un compromis entre une réduction de l'impôt des sociétés et ces deux taux d'imposition. D'autre part, le multiplicateur lié à l'impôt sur les gains en capital est positif, ce qui prédit une coordination d'une double réduction des taux d'imposition des sociétés et des gains en capital. De plus, les gains de bien-être des différents scénarios sont mitigés.

Mots-clés: Entrepreneuriat, Capital humain, Cycle de vie, Inégalité, Taxation optimale, Dynamique de transition, TCJA, Reduction d'impôts, Taxation séparée, Reforme fiscale, Corporations, Neutralité de revenue, Multiplicateur fiscal équilibré.

Abstract

This thesis explores the macroeconomic and distributional effects of taxation in the U.S. economy. The first three chapters take advantage of the interplay between entrepreneurship and wealth distribution while the last one discusses the trade-offs when financing a corporate tax cut under revenue neutrality.

Specifically, Chapter 1 provides evidence using the Panel Study of Income Dynamics (PSID) that occupation-specific human capital or business experience is quantitatively important in explaining income and wealth disparities among individuals over their life cycle. To capture the data patterns, I build on Cagetti and De Nardi (2006) occupational choice model, modified to feature life-cycle dynamics. I also introduce managerial skill accumulation which leads entrepreneurs to become more productive with experience. I then calibrate two versions of the model (with and without accumulation of business experience) to the same U.S. data. Results show that the model with business experience margin is the closest one.

Chapter 2's research question is timely to the recent tax reform enacted in the US, which is a major change of the tax code since the 1986 Tax Reform Act. The Tax Cuts and Jobs Act (TCJA) as of December 2017 significantly altered how business income is taxed in the US. I consider a dynamic general equilibrium model of entrepreneurship developed in Chapter 1 to provide a quantitative assessment of the macroeconomic effects of the TCJA, both in the short run and in the long run. The TCJA is modeled by its three key provisions : a new 20-percent-deduction rate for pass-throughs, a drop in the statutory tax rate for corporations from 35% to 21% and the reduction to 37% of the top marginal tax rate for individuals from 39.6%. I find that the economy experiences, a GDP growth rate of 0.90% over a ten-year window and average capital stock increases by 2.12%. These results are consistent with estimates made by the congressional budget office and the joint committee on taxation. With temporary provisions, the TCJA delivers a reduction in wealth and income inequality but the opposite occurs once provisions are

made permanent. In both scenarios, population suffers a welfare loss and finds them difficult to support.

Chapter 3 answers the normative question: *Should entrepreneurs be taxed differently?* Accordingly, I quantitatively investigate the desirability of an occupation-based taxation in the entrepreneurship model of Chapter 1, when transitional cohorts are explicitly taken into account. The main experiment is to move from the federal single progressive taxation for both labor income and business profit at the individual level to a differential tax regime where business income faces a proportional tax rate and labor income is still subject to the progressive scheme. I find that a tax rate of 40% is optimal. More generally, the optimal tax rate varies between 15% and 50%, increasing with the planner's aversion to inequality and decreasing with its relative valuation of future generations' welfare.

In the context of business tax reform, chapter 4 assesses revenue-neutral trade-offs when financing a corporate tax cut. To meet revenue neutrality, the policymaker uses three instruments to balance the government budget, namely labor income tax, dividend tax, and capital gains tax. I then construct a parsimonious general equilibrium model to derive balanced fiscal multipliers associated with corporate tax reform. Using a standard calibration, I show that both labor income tax and dividend tax multipliers are negative, suggesting a trade-off between a corporate tax cut and these two tax rates. On the other hand, the multiplier related to the capital gains tax is positive, which predicts the coordination of a double cut in both corporate and capital gains tax rates. Moreover, the welfare gains of the different scenarios are mixed.

Keywords : Entrepreneurship, Human capital, Life cycle, Inequality, Optimal Taxation, Transition path, TCJA, Tax cuts, Separate taxation,Tax Reform, Corporate, Revenue neutrality, Balanced fiscal multiplier.

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Introduction

Entrepreneurship is a core activity in the U.S. economy. It is an opportunity for agents to take on risk and innovate, create jobs and output growth. Since this activity is risky and may lead to default, entrepreneurs face financial constraints and must rely on their personal wealth to start up or scale up their ventures. As a consequence, business owners have higher saving rates and end up at the top-end of the income and wealth distributions (Quadrini, 2000; Gentry and Hubbard, 2004; Cagetti and De Nardi, 2006). The U.S. data show that business owners represent more than half of the wealthiest one percent and hold 60% of the wealth, the resulting inequality gap oftentimes triggers redistributive tax policies. However, the incentive to pursue productive entrepreneurship could be dampened if the government tax policy is very progressive.

These policies can often be controversial in public debates since economic inequality is also a growing issue. On the other hand, the supply-side logic argues that a special treatment of business income alleviates financial constraints and incentivizes entrepreneurs to take on more risk by increasing investment and employment. Thus the economy will benefit from the indirect effects of this dynamics. Most business income is earned by privately held businesses or pass-through entities (Sole proprietorships, Partnerships, and S-corporations). They are taxed like salaried workers. Therefore, the effects of a separate treatment of business income and labor income under the personal income tax code need to be understood. For instance, four nordic European countries -Norway, Finland, Sweden and Denmark- since the early 90s experience a dual income taxation. In this Nordic system, labor income and capital are taxed separately. On average capital income is taxed at a flat tax rate corresponding to the marginal tax for the first bracket of the progressive income code (Cnossen, 1999). In the US, the new special deduction provision of 20-percent for business owners contained in the recent tax reform known as Tax Cuts and Jobs Act (TCJA) as of 2017 is an example of an early attempt of the differential tax treatment of business owners relative to salaried workers. The (optimal) tax literature has been, however, almost silent on the issue of the separate taxation between business income and labor income. This thesis purports to fill this gap through a *positive* investigation (chapter 2) and a *normative* analysis (chapter 3) after showing that occupation-specific human capital or business experience is supported by the data (chapter 1).

Moreover, the TCJA significantly altered how business income is taxed in the US in general. A major provision in this tax bill is the permanent reduction of the top statutory tax rate from 35% to 21% for corporate firms. Critically, the reform fails to meet the revenue neutrality condition since it adds $1.5 trillions to the current deficit over the next decade. Therefore, the last chapter of this thesis addresses the following question: *How to finance a corporate tax cut?* The potential loss of government revenue might be detrimental to safety net programs such as Medicaid and Medicare.

Specifically, Chapter 1 provides evidence using the PSID that occupation-specific human capital or business experience is quantitatively important in explaining income and wealth disparities among individual over their life cycle. To capture the data patterns, I build on Cagetti and De Nardi (2006)' occupational choice model, modified to feature life-cycle dynamics. I also introduce managerial skill accumulation which leads entrepreneurs to become more productive with experience. I then calibrate two versions of the model (with and without accumulation of business experience) to same US data. Results show that the model with business experience margin is the closest one.

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Chapter 1

Unequal we stand: Human capital and Occupational choice over the Life cycle

1.1 Introduction

There are large differences in the amount of wealth and income held by different households in the US within-age and between age-cohorts; and any redistributive policy requires a good understanding of the drivers of such disparities with respect to individuals' lifespan. Therefore, the question of *what drives inequality over the life-cycle?* is still an open question although it has been tackled by many studies using quantitative dynastic and life-cycle frameworks with different mechanisms at play (Huggett, 1996; Quadrini and Ríos-Rull, 1997; De Nardi and Fella, 2017).

Entrepreneurship has been found to be very important in explaining large saving rates difference among households (Quadrini, 2000; Cagetti and De Nardi, 2006; Buera, 2009). For instance, the higher return to capital in active businesses and financial constraints incentivize agents to save more before transitioning into or staying in entrepreneurship, and then they end up having higher wealth-income ratios and saving rates than non-entrepreneurial households on average. Accordingly, using the PSID I document that over the life cycle[1] *i)* the age profile for wealth to income ratio is steeper for entrepreneurs, and *ii)* cumulative business experience is associated with higher income

[1] Quadrini (1999) points out the differences of wealth-income ratios between entrepreneurs and workers using the PSID waves from 1984 to1994 with respect only to occupation not age. In a cross-sectional analysis of SCF 1989 data Gentry and Hubbard (2004) also document higher wealth-income ratio for entrepreneurs by age-groups.

and wealth, favoring (re)entry and reduces exit. Furthermore, since occupational choice introduces mobility between entrepreneurship and salaried work over the life cycle, I analyze the data along this margin and find that *iii*) work-stayers have the lowest inequality and dispersion of income, *iv*) entrepreneur-stayers have as much inequality and income dispersion as switchers involving entrepreneurship.

To capture these patterns, I adopt a life-cycle model with occupational choice and uninsurable risk in both entrepreneurial and paid-work sectors. I also introduce managerial skill accumulation which leads entrepreneurs to become more productive with experience. The facts documented above suggest that the interconnection of occupational choice and cumulative (business) experience might be potentially an interesting channel contributing to the inequality depicted in the data. In the model, agents are *ex ante* identical and go through their lifespan subject to idiosyncratic dynamics of work and entrepreneurial ability, and an exogenous age-profile earnings for workers. However, provided that the occupational choice is endogenous and related to savings and realized entrepreneurial ability, two agents in a given cohort might not have the same income and wealth making heterogeneity within-cohort possible even without labor productivity shock. Another layer of heterogeneity arising endogenously in the model is the accumulation of human capital or business experience via a *learning-by-doing* process. This human capital could be interpreted as business acumen, know-how, book-keeping and so on, namely any kind of knowledge an individual might learn while being exposed to entrepreneurial activities. In fact, empirical studies find that entrepreneurship is experimentation allowing individuals to learn and increase their productivity or, even exit the business sector (Åstbro and Bernhardt, 2005; Amaral et al., 2011; Parker, 2013).

I find that entrepreneurial dynamics by age is consistent with the documented facts and the fit is overall better when human capital channel is considered. Since the model without entrepreneurial experience is calibrated to match the same target data moments as in the benchmark, the wealth and income distributions are almost similar in both models for the whole population. As already shown in previous papers, the entrepreneurship motive which generates high saving rates for would-be entrepreneurs is important on its own. I then rely on non-targeted data moments to cast light on the marginal contribution of cumulative business experience. The model with the *learning-by-doing* channel emerges as the closest one to the non-targeted data moments. For instance, adding the accumulation of entrepreneurial experience into the model without human capital increases the fraction of entrepreneurs in the top 1% of wealth distribution by 9 percentage point and their share of wealth by 7 percentage point. This increase is 6 percentage point for the top 5% wealthy entrepreneurs. I therefore argue that the future rewards of human capital if entrepreneurs sustain their position long enough in the business sector is quantitatively important in generating realistic dispersion among entrepreneurs. The main value-added of business experience introduced here is its capacity to bring the model that embodies it closer to the non-targeted data, specifically for entrepreneurs.

Using different inequality metrics I find that entrepreneurial-specific human capital via *learning-by-doing* is important in explaining income disparities between individuals with respect to occupation and age. Considering the variance of log income by occupation and age, the human capital model predicts an increasing pattern over the life cycle for entrepreneurs, which is consistent with the empirical counterpart. However, absent human capital accumulation, the model fails after age 30 to account for this upward-sloping dispersion in the business sector. I find a net contribution up to 0.5 percentage point near retirement for the model with human capital. The variance of *log* income also shows that there is twofold dispersion between workers and entrepreneurs in the data and in the model with business experience while the alternative model displays as much dispersion for worker as for entrepreneurs.

I also examine the inequality at the bottom and the top of the income distribution using the *log* 50/10 and the *log* 90/50 ratios, respectively. I find that there is more inequality at the bottom than the top for both occupations in the data, but this is reversed in the two models. In fact, the PSID data oversample low-income households inducing the bottom half of the income distribution to be a driver of the inequality. On the other hand, the presence of entrepreneurship in both model leads agents to save more, which makes the top half a driver of the inequality.

This work is related to the vast quantitative literature of savings and wealth accumulation over the life-cycle. Castaneda et al. (2003) emphasize higher productivity level to deliver a realistic wealth distribution for the US economy while De Nardi (2004) focus on bequest motive and intergenerational human capital transfer mechanism. The importance of preferences heterogeneity is investigated by Hendricks (2007). In a life-cycle model with idiosyncratic human capital accumulation, Huggett et al. (2011) show that differences in initial conditions as of age 23 explain most of the lifetime inequality. In a recent contribution, De Nardi et al. (2016) revisit a life-cycle environment while taking advantage of a structural estimation of the earnings process using PSID and administrative data. Kaymak and Poschke (2016) show that the increasing wage dispersion is the main driver of income and wealth inequality over half a century in the US. The current setup considers a life-cycle model with entrepreneurship margin.

The occupational choice connects this paper to the strand of the literature showing the importance of entrepreneurship in describing the saving behavior of wealthy households and the dynamics of wealth inequality (Quadrini, 2000; Evans and Jovanovic, 1989; Gentry and Hubbard, 2004; Hurst and Lusardi, 2004). The entrepreneurial mechanism is extensively discussed for a variety of purposes such as effect of wealth on transition probability into entrepreneurship (Hurst and Lusardi, 2004; Buera, 2006; Mondragón-Vélez, 2009), tax policy (Cagetti and De Nardi, 2009; Kitao, 2008; Meh, 2005), among others). My model highlights the endogenous business experience channel on inequality.

This paper also shares the intuition that the formal or informal human capital affects the labor market outcomes (Mincer, 1974; Becker, 1975). For example, Roys and Seshadri (2014) and Guner et al. (2015) show in an entrepreneurial choice model without financial constraint that human capital accumulation through schooling and on-the -job enhance workers-firm match quality. Investment in formal schooling is also a potential boost for entrepreneurship with trade-offs when there are borrowings constraints (Castro and Sevcik, 2016; Mestieri et al., 2016; Samaniego and Sun, 2016). On the other hand, human capital can be accumulated via experience or *learning-by-doing* process.[2] The potential of occupational-specific human capital in life-cycle economies without entrepreneurship explored in Keane and Wolpin (1997) four young in the NLSY 79 and in Kambourov and Manovskii (2009) for workers' wage inequality in the PSID.

The layout is as follows. Section 1.2 documents empirical facts that highlight the potential contribution of business experience in entrepreneurship dynamics and earnings over the life cycle. The model and its recursive formulation are presented in section 3.2. Section 3.3 discusses model calibration whereas the quantitative results are presented in section 4.3.2. Concluding remarks are given in section 1.6 concludes.

1.2 Evidence on entrepreneurial experience and inequality

In this section, I highlight some features of the data. Particularly, I emphasize the importance of entrepreneurship and accumulation of entrepreneurial experience by accounting for the inequality among individuals.

I use the Panel Study of Income Dynamics (PSID) waves 1968-2011 and the Survey of

[2] Using bayesian mechanism about beliefs in entrepreneurial skills and firms dynamics, Jovanovic(1980) gives an earlier theoretical contribution. Nonetheless, the empirical literature is grounded with mixed contributions of entrepreneurial human capital depending on how one defines it in the data. See (Åstbro and Bernhardt, 2005; **?**; Parker, 2013; Toth, 2014).

Consumer Finance (SCF 2010) data. I collect information on head of households (male and female) about economics outcomes (occupation status, annual labor income, annual hours worked, wealth) and demographics (age, sex, college degree). For the analysis below, I include households whose head *i*) is between 20-64, *ii*) and works positive hours. Income are transformed into 2011 US dollars using Consumer Price Index.

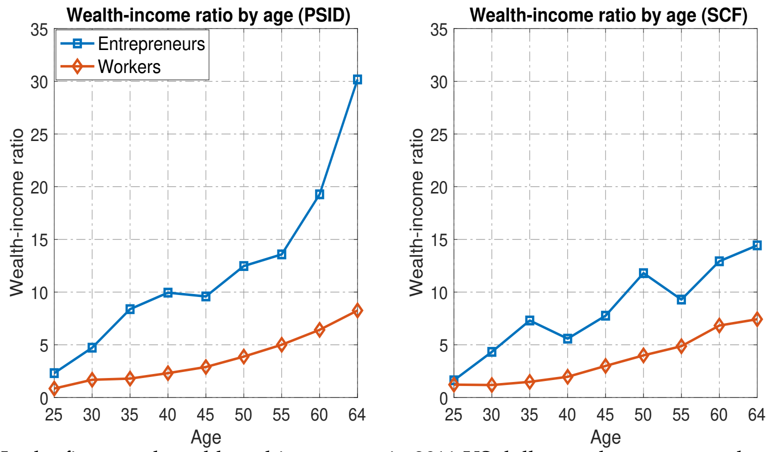
The notion of entrepreneur is a construct because there is no direct measure for it in the data. However, using the job status available in the data, I define an entrepreneur as individual who is actively managing his business (Cagetti and De Nardi, 2006).

Fact 1: The age profile for wealth to income ratio is steeper for entrepreneurs.

Since entrepreneurs rely more often on internal financing to start out with their endeavors, their are likely to hold higher wealth as compared to non-entrepreneurs. This can be shown by using for example wealth-income ratios, saving rates and other relevant statistics. Figure 1.1 shows the age-profile of wealth-income ratios among entrepreneurs and workers using two sets of data. One can notice two interesting patterns. First, the wealth-income ratio is upward sloping for both occupations over the life-cycle suggesting that agents accumulate more wealth while they age as is standard. The second trend is that, entrepreneurs' wealth-income ratio is consistently higher than that of non-entrepreneurial households[3] and, it rises approximately threefold from younger ages to retirement. On average, the wealth-income ratio is 11.15 for entrepreneurs and 3.21 for workers using the PSID, while in the SCF 2010 one finds wealth-income of 10.66 for entrepreneurs and 3.65 for workers. Therefore, the overall differences between entrepreneurs and workers could be investigated in the early stages of life and provide rationale to look at the inequality during the different stages of life. These facts are not only consistent over time since the first panel in figure 1.1 uses PSID data from 1984 to 2011, but also at the cross-sectional level provided that the use of SCF 2010 reveals a similar pattern in the second panel.

[3] Quadrini (1999) also finds similar results using three income classes with PSID data from 1984, 1989, and 1994 without the age dimension. On average, he finds wealth-income ratio for entrepreneurs amounting to 5.9 while that of workers is 2.86. Gentry and Hubbard (2004) use SCF 1983 and 1989 data and document the higher wealth-income ratio by quintile for households becoming or staying entrepreneurs.

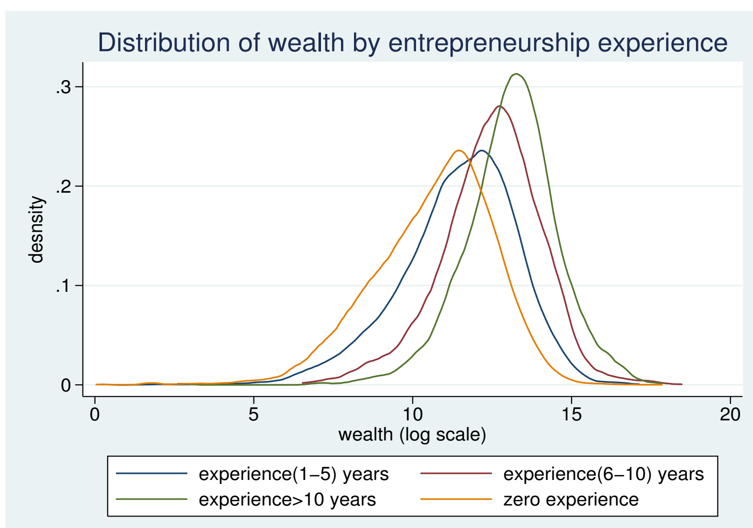
Figure 1.1: Wealth-income ratio over the life-cycle.



Note: In the first panel wealth and income are in 2011 US dollars and are computed as average by age before taking the ratio. Each dot represents an average over a five-year bin. The blue line is for entrepreneurs while the red one represents workers.

Fact 2: Cumulative business experience is associated with higher wealth and income.

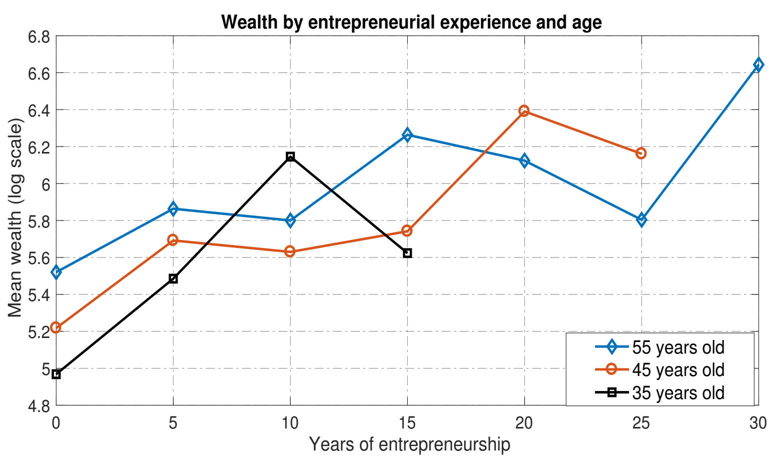
Figure 1.2: Wealth and entrepreneurial experience



One advantage of using the PSID is that it allows one to trace out the entrepreneurship spell for individuals, thereby highlighting the existence of serial entrepreneurs - individuals who have been entrepreneur more than once. The cumulative experience during a business tenure is an important human capital upon which an entrepreneur builds up his subsequent success. Figure 1.2 pinpoints the heterogeneity within the entrepreneurial sector with respect to entrepreneurship spell. It can be readily seen that the wealth distribution is shifting towards the right with a higher average for more experienced entrepreneurs.

Given that even in the same age-cohort, individuals may not have the same entrepreneurship spell, figure 1.3 plots the average wealth of three age groups with respect to experience. Thus, controlling for entrepreneurs' age shows that wealth increases with accumulated business tenure in almost all age group. I interpret these facts as evidence for accumulation of skills that are pertinent for effectively running one's business. However, the apparent facts depicted here may be artifacts that stems from intrinsic characteristics pertaining to individuals and/or the longitudinal nature of the data. Therefore, I make further analysis by estimating an income function for entrepreneurs[4] and control for these potential biases.

Figure 1.3: Wealth , age and entrepreneurial experience



I estimate the following income function:

$$lne_{it} = \psi_1 A_{it} + \psi_2 A_{it}^2 + \psi_3 Col_{it} + \psi_4 Exp_{it} + \psi_5 Exp_{it}^2 + v_i + \mu_t + \zeta_{it} \tag{1.1}$$

[4]One might suggest that a better statistic would have been earnings or business income instead of total income. While I acknowledge the relevance of this concern, the non-availability of this data in the PSID justifies the use of total income. Indeed, in the PSID, the business income for entrepreneurs is part of the total labor income of the head of the household in almost all the different PSID waves under consideration in this paper. Accordingly, business income is identified by the occupational status of the head of the household. Therefore, in this section I shall use these two concepts interchangeably.

where e_{it} is the real annual income of entrepreneur i in period t, A_i is individual's age, Exp is the cumulative years of entrepreneurship up to time t and controls for the entrepreneurial human capital accumulation. Since formal education is another channel to enhance one's skills, it may be the case that more educated entrepreneurs are prone to be persistent in the business sector. Therefore, variable Col is a dummy variable capturing this fact and takes value one if an individual has a college degree and zero, otherwise. Individual idiosyncratic characteristics rather than what explicitly outlined above are included in v_i, also the aggregate economic environment's impact is controlled for by μ_t. The variable ζ_{it} is the error term with the standard exogeneity assumption .

The results are summarized in table 1.1. The first two columns show the standard effects of age on the earnings process. That is the earning function is not linear with respect to age suggesting a decline after a certain age in the life course. Education allows an entrepreneur to increase his earnings (Column 2), the entrepreneurial experience could play a substitute role as indicated in column 3. In column 4 where the full model is estimated, the accumulated experience in the business sector is still statistically significant in the earning. The presence of education barely changes its contribution. Roughly, one more year of entrepreneurship increases the earnings by 5%.[5] This result provides an empirical support for including entrepreneurial human capital accumulation in terms of year of experience as an important driver of entrepreneurship dynamics.[6]

[5]This result is in line with findings in Kambourov and Manovskii (2009) and Toth (2014). Indeed, Kambourov and Manovskii (2009) show that, else being equal, 5 years of occupational tenure are associated with an increase in wages of 12% - 20% in the U.S. economy using the PSID. In a randomized experiment with Indonesian data, Toth (2014) finds that on average, an extra year of experience causes a 3% increase in net profit.

[6]This result is robust to the potential *selection bias* relative to occupation. In fact, I implement a two-stage Heckman correction model where I use the demeaned of total business experience at the individual level and its squared values as supplementary predictive variables for the selection probability. The choice of these instruments follows the approach in Altonji and Shakotko (1987). See Appendix 4.6.3 for the robustness check results.

Table 1.1: Income function estimates for Entrepreneurs

Log income	(1) loginc	(2) loginc	(3) loginc	(4) loginc
Age	0.125***	0.103***	0.101***	0.088***
	(0.026)	(0.011)	(0.0278)	(0.012)
Age^2	−0.001***	−0.001***	−0.001***	−0.001***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
College		0.289***		0.289***
		(0.041)		(0.041)
Business experience			0.054***	0.049***
			(0.122)	(0.009)
Business experience^2			−0.001**	−0.001***
			(0.0004)	(0.0004)
Constant	8.123***	8.344***	8.964***	8.930***
	(0.580)	(0.227)	(0.635)	(0.257)
Observations	11236	11236	11236	11236
R-squared	0.052	0.048	0.056	0.052
Number of entrepreneurs	2754	2754	2754	2754
Individual Fixed Effects	✓		✓	
Year Fixed Effects	✓	✓	✓	✓

Note: Income is *total labor income* data from PSID 1968 to 2011 in 2011 US dollars. Age is the age of the head of household, business experience equals the cumulative years of entrepreneurship up to period t, college is a dummy variable and an entrepreneur is a self-employed and business owner. Robust standard errors are reported in parentheses and the significance level defined as: $*10\%; **5\%; ***1\%$.

Fact 3: Entrepreneurship experience has predictive power on income and wealth, favors (re)entry and reduces exit rate.

Next, I estimate the impact of past business experience on entry to and exit from entrepreneurship. I fit the data with a Logit model with fixed effects for entry and re-entry and apply a survival analysis to the exit process. I show the results in table 1.2 and 1.3, respectively. Columns 1 and 3 in table 1.2 reveal that wealth and tenure positively affect (re)entry probability. The intuition behind this result is that wealth allows a would-be entrepreneur to get rid of external financial constraints to launch his venture, and previous entrepreneurial experience helps build up some confidence which incentivizes the entrepreneur to take on more risk. The existence of serial entrepreneurs in the data may be partially explained by this factor. The contribution of each factor or odds ratio is reported in columns 2 and 4, it gives the extent by which entry probability is increased with respect to each variable. For instance, a one-year tenured entrepreneur has 3 times more likely to re-enter into entrepreneurship than a would-be entrepreneur. This number is even higher than the one implied by wealth.

Table 1.2: Entry (Logit estimation)

	(1) Entry	(2) Odds ratio	(3) Entry	(4) Odds ratio
Age	0.0644^{***}	1.066^{***}	0.0561^{***}	1.0576^{***}
	(0.0176)	(0.0187)	(0.0174)	(0.0184)
Age^2	-0.001^{***}	0.998^{***}	-0.001^{***}	0.998^{***}
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
College	0.344^{***}	1.412^{***}	0.227^{***}	1.254^{***}
	(0.084)	(0.1185)	(0.0839)	(0.105)
Business experience	1.187^{***}	3.279^{***}	1.157^{***}	3.181^{***}
	(0.0253)	(0.0831)	(0.0250)	(0.0795)
Business experience^2	-0.037^{***}	0.963^{***}	-0.037^{***}	0.964^{***}
	(0.0011)	(0.0010)	(0.0011)	(0.0010)
Wealth			0.044^{***}	1.045^{***}
			(0.0038)	(0.0040)
Wealth^2			-0.001^{***}	0.999^{***}
			(0.00001)	(0.00001)
Constant	-5.306^{***}	0.005^{***}	-5.066^{***}	0.006^{***}
	(0.3812)	(0.0019)	(0.3779)	(0.0024)
Observations	52443	52443	52443	52443
Year Fixed Effects	✓	✓	✓	✓
Likelihood ratio	1427.70	1427.70	1256.02	1256.02

Note: PSID data from 1984 to 2011. Wealth is *family wealth* in 2011 US dollars divided by 100,000. Age is the age of the head of household , college is a dummy variable, business experience equals the cumulative years of entrepreneurship up to period t and an entrepreneur is a self-employed and business owner. Robust standard errors are reported in parentheses and the significance level defined as: $*10\%; **5\%; ***1\%$. An odds ratio greater than one suggests that the corresponding control increases (re)entry likelihood, otherwise it is a fall.

The hazard rate of failure or exiting entrepreneurship decreases with wealth and experience as indicated in table 1.3. Intuitively, given that entrepreneurship requires more internal financing, then the wealthier the entrepreneur the easier it is to self-finance and overcome borrowing constraints, and hence stay much longer in entrepreneurship. The tenure or business experience *per se* helps entrepreneur to have some business acumen and the like to quickly turns things around and adapt. This strength may incentivize individual not to exit. The time ratio gives more details in the contribution of each variable. Accordingly, one year of entrepreneurial experience reduces the exit probability by a factor of 14%, which slightly above that of 1% increase in one's wealth. Therefore the impact of experience on the exit dynamics is non negligible .

Again, these facts not only emphasize the well-known importance of wealth in entrepreneurship dynamics but, also highlight the complementarity effect of entrepreneurial experience.

Table 1.3: Exit (Survival analysis)

	(1) 1-Time ratio	(2) 1-Time ratio
Age	-0.011^{***}	0.004^{**}
	(0.002)	(0.002)
Wealth	-0.178^{***}	-0.103^{***}
	(0.018)	(0.014)
Business experience		-0.138^{***}
		(0.004)
Constant	-2.189^{***}	-7.345^{***}
	(0.596)	(1.132)
No. of subjects	9840	9840
No. of failures	1071	1071
Time at risk	58771	58771
Individual Fixed Effects	✓	✓
Year Fixed Effects	✓	✓

Note: PSID data from 1984 to 2011. Wealth is log of *family wealth* in 2011 US dollars , age is the age of the head of household, business experience equals the cumulative years of entrepreneurship up to period t and an entrepreneur is a self-employed and business owner. Robust standard errors are reported in parentheses and the significance level defined as: $*10\%; **5\%; ***1\%$. If (1-time ratio) is less than zero, then the corresponding control negatively affects Exit or increases survival. Otherwise, the reverse holds.

1.3 Model Economy

I build on Cagetti and De Nardi (2006) to allow individuals to choose occupation between paid-work and entrepreneurship. However, the simple life-cycle structure in their model does not enable one to fully describe the transition in and out of entrepreneurship. Therefore I adopt a life-cycle approach with lifetime uncertainty but without bequests. They work for the first R years followed by an inactive period of retirement. Individuals live J periods and start their life with zero initial wealth.

1.3.1 *Demographics and preferences*

The economy is inhabited by multiple cohorts of individuals of different ages. Each cohort is comprised of a continuum of measure one of individuals who live for a finite number of periods. Each period, an agent of age j decides whether to be an entrepreneur or a worker. Agent of age j maximizes the expected flow of utility given by

$$\mathbb{E}_0\left[\sum_{j=1}^{J}\beta^{j-1}u(c_j)\right] \tag{1.2}$$

where $u(c_j) = \frac{1}{1-\sigma}c_j^{1-\sigma}$ where σ is the rate of relative risk aversion. Each agent discounts future at rate $\beta \in (0,1)$.

1.3.2 *Technologies*

Work productivity

Labor supply is inelastic. A worker earns a market wage w per efficiency unit of labor ϵ_j, where ϵ_j denotes an age-specific productivity, which captures the average wage between workers of different age, and evolves deterministically along the life-cycle. Workers are also subject to idiosyncratic shocks, η, that are distributed according to the following stochastic AR(1) process.

$$\ln\eta_t = \rho\ln\eta_{t-1} + \epsilon_{\eta,t} \text{ where } \qquad \epsilon_{\eta,t} \sim N(0,\sigma_\eta^2)$$

Entrepreneurial experience

The more time an agent spends in the business sector, the more productive he becomes as an entrepreneur experience rises, making the entrepreneur's human capital an essential input for the business to succeed. I define business experience at any age j by the total number of years an agent has worked as an entrepreneur in their career. Formally, let $o(a, z, , \eta, j, \kappa) \in \{worker, entrepreneur\}$ denote the occupational choice given asset, abilities, age j, and entrepreneurial experience κ, the accumulation of this experience is as follows

$$\kappa' = \kappa + \mathbb{1}_{\{o(a,z,\eta,j,\kappa)=e\}}, \tag{1.3}$$

where

$$\mathbb{1} = \begin{cases} 1 & \text{if } o(a, z, \eta, j, \kappa) = entrepreneur \\ 0 & \text{otherwise} \end{cases} \tag{1.4}$$

Effective entrepreneurial skill

The agent launches his business with the cumulative experience acquired previously. Accordingly, the productivity in the business sector is now determined endogenously. To capture the risky nature of entrepreneurial activity I consider a stochastic entrepreneurial ability z following a Markovian process. Therefore, the business income of any entrepreneur might fluctuate. Let z_e denote the effective entrepreneurial skill at time t as

$$z_e = z\kappa^{\theta}, \quad \theta \in (0, 1) \tag{1.5}$$

z_e is the effective entrepreneurial ability by which production will be carried out in the business sector and has the same stochastic process as the underlying z, and θ is the elasticity of the effective human capital with respect to experience.

Entrepreneurial production

The production technology available in the entrepreneurial sector is in line with the span-of-control assumption (Lucas Jr, 1978). The entrepreneur rents working capital k at interest rate r and labor input l at market wage w in a constrained financial market environment. Markets arrangement are such that, the entrepreneur is able to borrow only up to a fraction $\lambda \geq 1$ of his initial wealth. Capital depreciates at rate δ. Denoting the business income of the entrepreneur by π we have

$$\pi(a, z, \kappa) = \max_{l \geq 0,\, k \leq \lambda a} z\kappa^{\theta}(k^{\alpha} l^{1-\alpha})^{\gamma} - \delta k - r(k - a) - wl \tag{1.6}$$

where $\alpha, \gamma, \in (0,1)$. Solving for interior solution along with concavity property of the profit function one obtains optimal size of the firm as

$$k^* = \min\left\{\lambda a, \quad (\gamma\alpha z\kappa^\theta)^{\frac{1}{1-\gamma}}\left[\frac{(1-\alpha)(r+\delta)^{1-\frac{1}{\gamma(1-\alpha)}}}{\alpha w}\right]^{\frac{\gamma(1-\alpha)}{1-\gamma}}\right\} \tag{1.7}$$

$$l^*_{noconstr} = \frac{(1-\alpha)(r+\delta)}{\alpha w}k^* \tag{1.8}$$

$$l^*_{constr} = \left[\frac{\gamma(1-\alpha)z_e k^{*\alpha\gamma}}{w}\right]^{\frac{1}{1-\gamma(1-\alpha)}} \tag{1.9}$$

The corresponding profit functions are given by

$$\pi^{noconstr}(a,z,h) = (1-\gamma)(z_e)^{\frac{1}{1-\gamma}}\left[\frac{\gamma(1-\alpha)}{w}\right]^{\frac{\gamma(1-\alpha)}{1-\gamma}}\left[\frac{\alpha\gamma}{r+\delta}\right]^{\frac{\alpha\gamma}{1-\gamma}} \tag{1.10}$$

and

$$\pi^{constr}(a,z,h) = (1-\gamma(1-\alpha))(z_e)^{\frac{1}{1-\gamma(1-\alpha)}}\left[\frac{\gamma(1-\alpha)}{w}\right]^{\frac{\gamma(1-\alpha)}{1-\gamma(1-\alpha)}}(\lambda a)^{\alpha\gamma} - (r+\delta)\lambda a \tag{1.11}$$

Equation 1.7 shows the non-convexity in the optimal capital demand due to the borrowing constraint faced by the individual entrepreneur. The first part gives the constrained demand i.e. when the borrowing constraint is binding, therefore the size of the firm is tied to the business owner's wealth. By contrast, the second term defines the unconstrained optimal size that the entrepreneur can choose. The corresponding labor demand and profit when entrepreneur is not constrained is given in 1.8 and 1.10 while that of the binding situation is set in 1.9 and 1.11.

Non-entrepreneurial sector:

Not all businesses in the economy are performed by individual entrepreneurs. There is also a group of relatively large and unconstrained firms which I refer to as corporations. I then suppose that these corporations are represented by a single corporate firm using a constant-returns-to-scale production function. To capture the effect of corporate taxation, the aggregate corporate firm pays a proportional corporate tax τ_c on its operating profit which is defined as production net of labor cost and capital depreciation.[7] The corporate firm then solves the following:

$$\max_{K_c, L_c > 0} A_c K_c^{\alpha} L_c^{1-\alpha} - (\tilde{r} + \delta) K_c - w L_c \tag{1.12}$$

with $\tilde{r} = r/(1 - \tau_c)$

First order conditions give rise to

$$\tilde{r} + \delta = \alpha A_c \left(\frac{K_c}{L_c} \right)^{\alpha - 1} \tag{1.13}$$

$$w = (1 - \alpha) A_c \left(\frac{K_c}{L_c} \right)^{\alpha} \tag{1.14}$$

1.3.3 *Government and tax system*

Government levies proportional taxes on consumption(sales tax) $T_s = \tau_s C$, progressive taxes on personal income T_y and uses the proceeds to finance an exogenous outlay G and retirement benefits, B. I consider the below tax scheme on income.

$$y^d = \xi \min\{y_{top}, y\}^{1-\tau} + (1 - \tau_{\max}) \max\{0, y - y_{top}\} \tag{1.15}$$

$$t(y) = y - y^d \tag{1.16}$$

where y^d is agent's disposable income, y the total income and $t(y)$ the amount of tax collected. The first term in equation 3.8 captures the progressivity of the U.S. personal income tax which can be approximated by a log-linear function outside the top income bracket[8] (Benabou, 2002; Heathcote et al., 2014a; Bakış et al., 2015). The second term

[7] Indeed, operating profit is expressed as $\tilde{\pi} = A_c K_c^{\alpha} L_c^{1-\alpha} - \delta K_c - w L_c$. One can then show that $\tau_c \tilde{\pi} = \tau_c \tilde{r} K_c$. Thus, the before-corporate tax is given by $\tilde{r} = r/(1 - \tau_c)$. Moreover, setting the interest rate in this way prevents pass-through entities to be subject to the corporate taxation (double taxation), which is consistent with the actual U.S. tax code.

[8] This tax schedule rules out lump-sum transfers but allows agents to receive tax rebates or transfers as long as their total income $y \in (0, \xi^{\frac{1}{\tau}})$.

represents the tax liabilities of those individuals in the top end of income distribution with $\tau_{\max}$ the top marginal tax rate (Kaymak and Poschke, 2016). The income level y_{top} is the critical level equalizing the marginal tax rates. That is, $1 - \xi(1-\tau)y_{top}^{-\tau} = \tau_{\max}$. The tax system progressivity is captured by τ. Accordingly, if $0 < \tau < 1$ taxation is progressive, meaning an increase in marginal tax with respect to income. A regressive schedule, on the other hand, occurs when $\tau < 0$. The parameter ξ in equation 3.8 represents the average level of taxation in the economy and it also allows one to balance the government's budget at the equilibrium. Each period government's budget balances as

$$G + B = T_s + T_y + \tau_c \tilde{r} K_c \tag{1.17}$$

1.3.4 Recursive formulation

Households maximize the expected flow of utility given in 3.2.1. I assume no aggregate uncertainty and prices are constant in the steady state.

Each period, an age-j individual starts with an initial wealth a, productivity η, entrepreneurial ability z, experience κ, and then chooses his current occupation. Workers earn income from labor, make consumption and savings decision. Entrepreneurs choose the working capital and labor input demand subject to the collateral constraint. Moreover, the entrepreneur gains one period of experience which will be essential in his subsequent ventures.

Agent's problem

a-Retiree's problem

After retirement, agents live off their savings and retirement benefits (b). Pension is paid out to any retiree regardless of his pre-retirement occupation. The problem of a retired agent for ages $j \in \{R, R+1, \ldots, J\}$ is given by

$$v_j(a) = \max_{a'} \left\{ u(c) + \beta v_{j+1}(a') \right\} \tag{Pr}$$

$$y_r = ra + b \tag{1.18}$$

$$(1 + \tau_s)c + a' = y^d(y_r) + a \tag{1.19}$$

$$a \geq 0 \tag{1.20}$$

$$v_{J+1}(a) = 0 \tag{1.21}$$

Thus, during the retirement agent just chooses his next period asset holdings. To the extent that the agent's lifetime ends at J, equation 3.14 gives the one period ahead terminal utility which is zero. Recall that $y^d(.)$ is the net-of-tax schedule given in 3.8.

b-Working agent's problem

Before retirement, any agent in the economy has the following choice:

$$v_j(a, z, \eta, \kappa) = \max \left\{ v_j^w(a, z, \eta, \kappa), v_j^e(a, z, \eta, \kappa) \right\} \tag{1.22}$$

where $v_j^w(a, z, \eta, \kappa)$ and $v_j^e(a, z, \eta, \kappa)$ are the value functions of worker and entrepreneur, respectively.

b1-Worker's problem

Conditional on being on the labor market, an age-j worker solves the following recursive problem by choosing next savings and occupation.

$$v_j^w(a, z, \eta, \kappa) = \max_{a'} \left\{ u(c) + \beta \sum_{z', \eta'} \psi(z', \eta' | z, \eta) v_{j+1}(a', z', \eta', \kappa') \right\} \tag{Pw}$$

subject to

$$y_w = w \eta \epsilon_j + ra \tag{1.23}$$

$$(1 + \tau_s)c + a' = y^d(y_w) + a \tag{1.24}$$

$$\kappa' = \kappa \tag{1.25}$$

$$a \geq 0, \quad j = 1, 2, \ldots, R - 1 \tag{1.26}$$

The expectation is taken with respect to the underlying Markovian productivity distribution $\psi(z', \eta' | z, \eta)$ for the two abilities with the assumption that they are not correlated.[9] The worker's income stems from efficiency unit of labor per market wage. The budget constraint in (3.17) states that although the agent is bestowed with a given entrepreneurial productivity z, his current income does not depend on this productivity because he has chosen to be a paid-worker anyway. However, in a forward-looking fashion, he knows that the next period entrepreneurial talent is subject to the evolution of

[9] This assumption is also made in Cagetti and De Nardi (2006). They compute a robustness check with correlated abilities but results are not affected.

the current productivity endowment, and so is his next occupation. Put differently, any agent in the model is a potential entrepreneur until he decides not to be one. Agent's next period savings are bounded below given that agent is prevented to roll over debt, namely net wealth is non-negative. Provided that a worker does not carry out production technology for his own, he does not accumulate this specific entrepreneurial experience.[10] The equation 3.18 then shows the static accumulation of entrepreneurial skill.

b2-Entrepreneur's problem

The recursive problem of an entrepreneur is now stated as follows

$$v_j^e(a, z, \eta, \kappa) = \max_{a'} \left\{ u(c) + \beta \sum_{z', \eta'} \psi(z', \eta' | z, \eta) v_{j+1}(a', z', \eta', \kappa') \right\} \tag{Pe}$$

subject to (3.4)-(1.7), (3.19) and

$$y_e = \pi(a, z, \kappa) \tag{1.27}$$

$$(1 + \tau_s)c + a' = y^d(y_e) + a \tag{1.28}$$

$$\kappa' = \kappa + 1 \tag{1.29}$$

The main differences between the two occupations are the income earned in the current period and the accumulated human capital. In fact, the profit function $\pi(.)$ is a complex function which incorporates the borrowing constraints faced by the entrepreneur as described in section 3.2.2. The occupation-specific human capital gained in the business sector is defined in Eq (3.22) and translates the *learning-by-doing* process embedded in entrepreneurship. Hence, it is a latent variable behaviorally determined.

Equilibrium

At each point in time, individuals differ from one another with respect to age j and to state $s = (a, z, \eta, \kappa, o)$ i.e. asset holdings a, entrepreneurial productivity z, work productivity η, entrepreneurial experience κ and occupation $o \in \{W, E, Retiree\}$. Let

[10] One could possibly think of a similar occupation-specific human capital accumulated in paid-work sector. This extension not only will increase the computation burden but also will not change the intuition carried over by the current setup. Indeed, one could take the relative of the two human capital and then normalize the paid-working one rendering models equivalent. On the other hand, one could also argue that, since the model explicitly keeps track of the labor efficiency unit, the human capital in the paid-work sector is somehow taken into account.

$a \in \mathbb{A} = \mathbb{R}_{+}, z \in \mathbb{Z}, \eta \in \mathbb{H}, \kappa \in \mathbb{K}$ and $o \in \mathbb{O}$, and $\mathbb{S} = \mathbb{A} \times \mathbb{Z} \times \mathbb{H} \times \mathbb{K} \times \mathbb{O}$ the entire state space. Let $(\mathbb{S}, \mathcal{F}(\mathbb{S}), \phi j)$ be a space of probability, where $\mathcal{F}(\mathbb{S})$ is the Borel σ-algebra on $\mathbb{S}$: for each $\mathcal{B} \subset \mathcal{F}(\mathbb{S})$, $\phi_j(\mathcal{B})$ denotes the fraction of agents aged j that are in $\mathcal{B}$. Given the age j distribution ϕ_j, $Q_j(s, \mathcal{B})$ induces the age $j+1$ distribution ϕ_{j+1} as follows. The function $Q_j(s, \mathcal{B})$ determines the probability of an agent at age j and state s to transit to the set $\mathcal{B}$ at age $j+1$. The policy function for savings, consumption, entrepreneurial capital and entrepreneurial labor is given by $g_j^a(s), g_j^c(s), k_j(s)$ and $l_j(s)$, respectively.

Definition . Given a tax structure $\{\tau_s, \tau_c, \tau_I, \tau_{max}, \xi, b\}$, a stationary recursive competitive equilibrium is a set of **functions** $\{v_j^w, v_j^e, v_j, g_j^a, g_j^c, k_j, l_j(s)\}_{j=1}^J$, and **prices** $\{\tilde{r}, w\}$ such that

(i) given prices, the functions solve the household problem in (Pw), (Pe) and (3.15);

(ii) the prices satisfy the marginal productivity conditions i.e. $\tilde{r} = F_{K_c}(K_c, L_c) - \delta$ and $w = F_{L_c}(K_c, L_c)$;

(iii) capital and labor markets clear :

$$\sum_{j=1}^{R-1} \int_{\mathbb{S}} k_j(s) d\phi_j + K_c = \sum_{j=1}^{J} \int_{\mathbb{S}} g_j^a(s) d\phi_j$$

$$\sum_{j=1}^{R-1} \int_{\mathbb{S}} l_j(s) d\phi_j + L_c = \sum_{j=1}^{R-1} \int_{\mathbb{S}} \epsilon_j \eta d\phi_j$$

(iv) given the decision rules, $\phi_j(s)$ follows the law of motion:

$$\phi_{j+1}(\mathcal{B}) = \int_{\mathbb{S}} Q_j(s, \mathcal{B}) d\phi_j, \forall \mathcal{B} \subset \mathcal{F}(\mathbb{S});$$

(v) the government balances its budget:

$$G + B = \tau_c \left(\frac{r}{1 - \tau_c} \right) K_c + \tau_s \sum_{j=1}^{J} \int_{\mathbb{S}} g_j^c(s) d\phi_j + \sum_{j=1}^{J} \int_{\mathbb{S}} [y_j - y_j^d] d\phi_j$$

where $y_j^d = \xi \min\{y_{top}, y_j\}^{1-\tau} + (1 - \tau_{\max}) \max\{0, y_j - y_{top}\}$
$y_j = \mathbb{1}_{\{occup=worker\}} y_j^w + \mathbb{1}_{\{occup=entrepreneur\}} y_j^e + \mathbb{1}_{\{Retiree\}} y_j^r$.

1.4 Calibration

In this section, I discuss the parametrization of the model economy. The calibration procedure is then carried out in two steps: I first consider a set of fixed parameters drawn upon the literature (table 1.4) and thereafter I jointly calibrate the remaining parameters so that the model economy is consistent with a set of aggregate statistics of the US. economy (table 1.6). I use the PSID (1968-2011) and the SCF (2010) to compute some relevant statistics.

Table 1.4: Fixed parameters

Parameter	**Symbol**	**Value**	**Source**
Preferences, demographics and technology			
Risk aversion	σ	2.0	Conesa et al. (2009)
Lifetime	J	61.0	Average US data
Retirement	R	46.0	Average US data
Corporate capital income share	α	0.33	Gollin (2002)
Depreciation rate	δ	0.06	Stokey and Rebelo (1995)
Technology parameter	A_c	1.00	Normalization
Borrowing limit	λ	1.50	Kitao (2008)
Labor productivity			
productivity and process	η, P_η	See Appendix 4.6.1	Storesletten et al. (2004)
Age-dependent efficiency unit	$\{\epsilon_j\}$	See Appendix 4.6.1	own estimate using PSID
Government			
Government spending	G/Y	0.17	Conesa et al. (2009)
Replacement rate	τ_{rep}	0.40	Kotlikoff et al. (1999)
Consumption tax	τ_s	0.05	Imrohoroglu and Kitao (2010)
Tax progressivity	τ	0.17	Bakış et al. (2015)
Top marginal tax	$\tau_{\max}$	0.396	US data
Deduction rate for entrepreneurs	τ_d	0.00	US data
Average effective corporate tax rate	τ_c	0.29	Gravelle (2014)

1.4.1 *Preferences*

The relative risk aversion parameter σ is set to 2 following Conesa et al. (2009). The subjective discount factor β is jointly set to 0.951 so that, in equilibrium, the capital-output ratio is 2.65.

1.4.2 Demographics and endowments

Individuals enter the economy at real age 20 (model period 1) and live up to a maximum age of 80 years (model period $J = 61$). Since the mandatory retirement age in the US is 65, I allow agents to work until model period 45 and then retire at $R = 46$. Agents are endowed with one unit of time which they supply inelastically irrespective of the occupation.

Labor efficiency unit $\{\epsilon_j\}$ are computed using hourly earnings from the PSID[11] and are intended to capture the standard hump-shape of the cross-sectional earnings profile. Earnings increase with age and during the prime-age but start declining after retirement. The idiosyncratic shock η takes on six possible values $\eta \in (\eta_1, \eta_2, \eta_3, \eta_4, \eta_5, \eta_6)$ where the first five are computed using an approximation of an AR(1) process after Tauchen (1986) as defined in section 3.2.2. Following estimations by Storesletten et al. (2004) I set the persistence coefficient ρ and the residual variance σ_η^2 to 0.95 and 0.03, respectively.[12]

However, the sixth productivity level η_6 is aimed at capturing an awesome state attainable with a small likelihood (Castaneda et al., 2003; Kaymak and Poschke, 2016). From any other state, η_6 can be reached with the same probability $\phi_{.6}$, but once individuals visit this state, they can only fall back to the medium ability η_3 with probability ϕ_{63}. Accordingly, one has to calibrate three parameters stemming from the workers' side : the two probabilities $\phi_{.6}$ and ϕ_{63}, and the awesome state η_6. The data moments as targets are the overall economy wealth Gini of 0.80, workers' total labor income Gini of 0.52 and the income share held by the top percentile of the income distribution which amounts to 20% in the (SCF, 2010).

On the other hand, the entrepreneurial ability is defined by four different values $z \in \{z_1, z_2, z_3, z_4\}$. I set the first one to 0 so that any individual with this ability will always choose to be a worker. By introducing an average ability $\bar{z}$ and a deviation ability $\hat{z}$, I relate the four abilities as $\{z_1, z_2, z_3, z_4\} = \bar{z} * \{0, 1 - \hat{z}, 1, 1 + \hat{z}\}$, where $\hat{z} \in (0, 1)$, and therefore I am left with two abilities to calibrate. To ensure a parsimonious calibration of the transition probability P_z, I follow Kitao (2008) by assuming that agents can only move up and down to the closest state:

[11]See Apenndix 4.6.1 for more details on the computation of these efficiency units.

[12]Using different models, Storesletten et al. (2004) find that ρ ranges from 0.94 to 0.96, and the variance lies between 0.014 and 0.04. I then take the average values of both estimates. This values are consistent with the range of estimates in the literature. For instance, $\rho = 0.94$ and $\sigma_\eta^2 = 0.016$ are found in Kaplan (2012).

$$P_z = \begin{pmatrix} p_{11} & 1-p_{11} & 0 & 0 \\ p_{21} & p_{22} & 1-p_{21}-p_{22} & 0 \\ 0 & p_{32} & p_{33} & 1-p_{32}-p_{33} \\ 0 & 0 & 1-p_{44} & p_{44} \end{pmatrix}$$

The middle two rows probabilities are assumed to be identical, namely $p_{21} = p_{32}$ and $p_{22} = p_{33}$. I therefore calibrate the six parameters associated to the process of z, the span-of-control γ and the return to entrepreneurial human capital θ by matching eight targets in the steady state: the fraction of entrepreneurs in the economy, the average entry rate of workers into entrepreneurship, the average exit rate of entrepreneurs, the share of capital used in the entrepreneurial sector, the average tenure in the business sector, the share of income earned by entrepreneurs, the share of business income held by top entrepreneurs to that held by workers, and the ratio of entrepreneurs' wealth-income ratio to that of workers over the life-cycle.

Using the definition of an entrepreneur as a self-employed business owner who actively manages his venture, Cagetti and De Nardi (2006) find 7.5% of the US population falls in this category. The same characterization of an entrepreneur gives rise to 6.85% in the PSID and 8.48% in the SCF. Thus, I choose to target a middle figure of 7.5%. If one relaxes this definition by defining an entrepreneur as self-employed or business owner, the fraction of entrepreneurs can increase up to 12% (Quadrini, 2000; Gentry and Hubbard, 2004). The annual average entry and exit rates are set to 2.5% and 20%, respectively using the PSID (1968-2011). These targets are close enough to the 2.3% and 22% in Cagetti and De Nardi (2006). To capture the split of the economy in two sectors : corporations and incorporate businesses; I set the entrepreneurial capital share to 35% as Quadrini (2000). The panel nature of the PSID allows one to compute the average years an individual stays in entrepreneurship, I find seven years on average and then use it as a target. This data moment is clearly to help identify the contribution of the entrepreneurial specific human capital channel emphasized early on.

Some aspects of income property are also targeted. The model is required to match the share of income held by entrepreneurs of 20%. In Quadrini (2000), 12% of the population are defined as entrepreneurs and hold 22% of the income, but the lower fraction of entrepreneurs in my model leads me to choose a lower target of 20% which is consistent with their income share of 19.4% in the SCF (2010) . As seen in the income decomposition using the Theil index, the within-entrepreneur inequality is high enough. Therefore, I choose to target the fraction of business income held by the top 1% earners. I found in the SCF, a share of 39,95%. To discipline the model to capture a realistic degree of inequality seen in the data over the lifespan, I target the ratio of entrepreneurs' wealth-income ratio to that of workers over the life cycle. As shown in the evidence section 1.2, on average, the wealth-income ratio is 11.15 for entrepreneurs and 3.21 for workers using the PSID, while in the SCF 2010 one finds wealth-income of 10.66 for entrepreneurs and 3.65 for workers. Therefore, the ratio of the two occupations' wealth-income ratio is 2.9 and 3.4 for the PSID and the SCF, respectively. I then choose to target a conservative figure of 3. One rationale guiding this choice is to allow the model to capture the persistent inequality over the life cycle between the two occupations.

The current baseline admittedly relies on one more channel, namely the accumulation of entrepreneurial experience to analyze the entrepreneurial dynamics and wealth implication. Therefore, to cast more light on this avenue, I recalibrate the model without human capital accumulation by targeting 11 moments out of the previous 12 moments. Indeed, the absence of the experience return θ reduces this number, and I dropped the average business tenure as a moment target.

Table 1.5: Jointly calibrated parameters

Parameter	Symbol	Value for HC model	Value for no HC model
Labor productivity process			
higher productivity level	η_6	21.75	32.98
probability of reaching this state from anywhere	$\phi_{.6}$	0.003	0.002
Median-reverting probability	ϕ_{63}	0.128	0.178
Entrepreneurial ability process			
Entrepreneurial ability levels	$\bar{z}$	1.150	1.110
	$\hat{z}$	0.213	0.668
Transition probabilities	p_{11}	0.987	0.929
	p_{21}	0.487	0.567
	p_{22}	0.313	0.210
	p_{44}	0.702	0.846
Remaining parameters			
Discount factor	β	0.951	0.942
Span-of-control parameter	γ	0.830	0.895
Return to entrepreneurial experience	θ	0.236	1.000

1.4.3 *Technology and market arrangement*

In the corporate sector, the share of output that goes to the capital α is set to 0.33 as is standard in the macro literature (Gollin, 2002). The productivity parameter A_c is normalized to unity. Capital depreciates in both sectors at the same rate δ which I fix to a standard value of 6% (Stokey and Rebelo, 1995).

One important aspect of entrepreneurship if the existence of financial constraint that could prevent one from starting or expanding a venture. Empirical estimations such as Evans and Jovanovic (1989) have shown the relevance of such constraints.[13] The financial sector then allows entrepreneurs to borrow up to a fraction $\lambda = 1.5$ of their assets.

1.4.4 *Government and tax system*

Government consumption is set to 17% of the output following Conesa et al. (2009). This outlay is funded by consumption and income tax proceeds. I fix the proportional consumption tax τ_c to 5% (Imrohoroglu and Kitao, 2010). The income tax progressivity τ in US economy estimates from Bakış et al. (2015) and Heathcote et al. (2014a) lie between 17% to 18.5%. I use the lower bound of these estimates in the benchmark economy as in Bakış et al. (2015).

Table 1.6: Goodness of fit

	Data	**Model HC**	**Model no HC**
Capital-output ratio	2.65	2.60	2.66
Overall wealth Gini	0.81	0.82	0.82
Income Gini for workers	0.52	0.52	0.54
Income share for top earners (%)	20.0	20.4	20.0
Fraction of Entrepreneurs (%)	7.50	7.10	6.88
Entry rate into entrepreneurship (%)	2.50	2.60	4.00
Exit rate from entrepreneurship (%)	20.0	20.9	20.0
Average Tenure in Entrepreneurship (years)	7.16	8.00	–
Non-corporate capital share (%)	35.0	35.6	36.42
Business income share for top Entrepreneurs (%)	40.0	37.0	33.86
Entrepreneurs' share of Total income (%)	20.0	20.8	18.80
Wealth-Income ratio (Entrepreneur to Worker)	3.00	2.75	2.201

[13] The relevant of borrowing constraint is extensively used in quantitative macro models (Kitao (2008); Buera (2009) , and references therein). However, Hurst and Lusardi (2004) challenged this view by arguing that borrowing constraint are non active for households below the 95% of the wealth distribution. Then the entry probability is only increasing with wealth for households in the top-end 5% of the wealth distribution.

1.5 Quantitative results

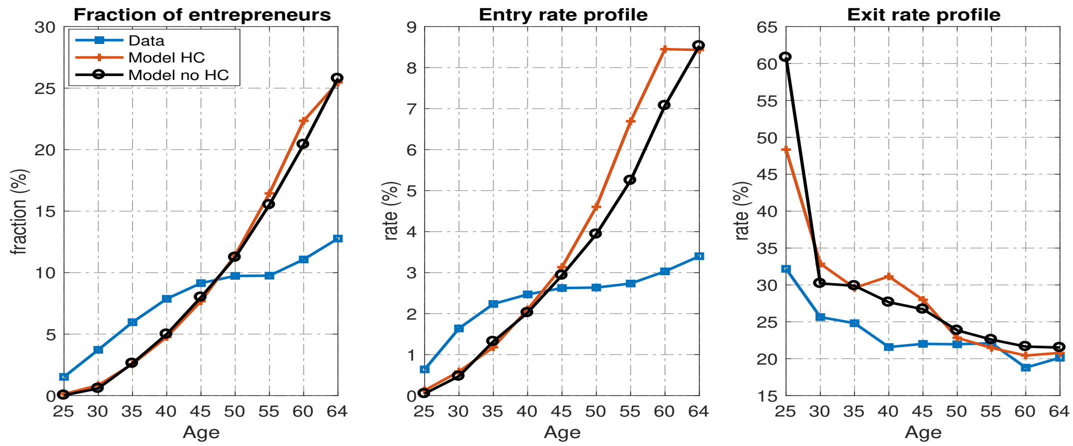
The quantitative results of the baseline economy is presented in this section. Table 1.6 summarizes the performance of the model economy with respect to the data targets. Overall, the model with human capital has a good fit even though it overshoots in a small extent the average tenure in the business sector and underestimates the entrepreneurs' total assets share relative to that owned by workers. The third column also shows the model without human capital valuation as relatively a good job respect to the data.[14] One can then evaluate the benchmark economy in many dimensions. For instance, the entrepreneurship dynamics can be reviewed, income and wealth distribution analyzed in the general population and with respect to each occupation.

1.5.1 Entrepreneurship over the life cycle

In the benchmark economy, only the averages of entry rate, exit rate and the fraction of entrepreneurs in the whole population have been targeted. It is now interesting to evaluate how the model delivers the entrepreneurship dynamics over the life-cycle. The profiles in the entrepreneurship are given in figure 1.3 .

[14]One must recall that in the scenario without valuation of business experience, I re-calibrate the model to match the same data targets except the average tenure in entrepreneurship. The model then requires for instance, higher discount rate and labor productivity levels. The calibrated parameters are available but not reported here. On the other hand, when I just consider the model with human capital and shut off the business experience channel without a recalibration exercise, the model with no human capital performs poorly. Therefore, using this way of comparison can overstate the margin of the human capital introduced in the present model.

Figure 1.4: Entrepreneurship by age



Note: In all panels, red represents model with human capital, black the model without human capital and the blue indicates data. Data are from the PSID (1968-2011) where an entrepreneur is defined as self-employed and business owner. Each dot represents a five-year bin average.

The patterns delivered by the model economy in both cases (with and without human capital) mimic overall the data. The first panel in figure 1.4 shows that the fraction of entrepreneurs in both model evolves as in the data up to age 45 and keeps increasing steeply until retirement with around 25% of older entrepreneurs at retirement. The fact that the two models are almost identical in the first half of the life cycle suggests that it takes time to build up this specific human capital and earn some return on it. To the extent that agents enter the economy with zero net worth and face collateral constraints at the entry of entrepreneurial sector, the quantitative importance for younger generation is limited. However, the business experience tends to be more valued later in life since a gap between the two models' entry rate exists after age 45 (middle panel). The third panel shows that in general, older entrepreneurs are more experienced which induces them to stay longer in the business sector relative to younger generations. Even though this results holds for the two setups, there is still a relative advantage for the model accounting for business experience. The patterns depicted here are in line with the third evidence on the entry and exit margins shown in section 1.2.

It is worth questioning the observation that both models deliver steeper life-cycle profiles relative to data. Indeed, after age 45 the models predicts higher fraction for entrepreneurs in the population (panel a) and higher entry rates as well (panel b). One argument that may explain this display is the deterministic nature of the life cycle considered in both models. Since there is no probability of dying in the economy, each cohort has the same number of individuals. However, entrepreneurship requires first personal net worth and experience later on, which are accumulated primarily by older cohorts. Therefore, a steeper slope emerges as a consequence of more non-dying individuals entering or persisting in entrepreneurship.[15]

1.5.2 Wealth and income distribution

Wealth and income inequality in the benchmark economy and its data counterpart are shown in table 1.7 where distributions are broken down into top 1% to top 30% shares. Recalling that the model in the calibration procedure does not explicitly target the wealth and income distribution, it is then the case that the benchmark captures the contribution of entrepreneurial human capital among individuals over the life cycle. Figures in the two benchmark economies are close to their data counterparts. However, the models miss the top 1% wealth share with respect to data. Thus, there is more positive skewness in the data than in the benchmark economy with or without accumulation of entrepreneurial capital. This result is not surprising since entrepreneurship motive coupled with dynastic wealth accumulation and bequest are important ingredients to perfectly match data [16,17] (Quadrini, 2000; Cagetti and De Nardi, 2006).

Since the model without entrepreneurial experience is calibrated to match the same target data moments as in the benchmark, the wealth and income distributions are almost similar in both models for the whole population. As already shown in previous papers, the entrepreneurship motive which generates high saving rates for would-

[15]This assumption of deterministic aging of individuals in the models are not too far fetched because the U.S. and almost the developed countries have began to face a large increase in the share of old people in the population. According to the U.S. Census Bureau's 2017 National Population Projections , by 2030, all baby boomers will be older than age 65. This will expand the size of the older population so that 1 in every 5 residents will be retirement age.

[16]As is well-known in entrepreneurship and wealth dynamics literature, the entrepreneurship motive coupled with others channels can perfectly match the data. For instance, Quadrini (2000) in a infinite Aiyagari-type model , shows that the high savings rates of entrepreneurs to overcome stringent borrowing constraints generates close wealth inequality with respect to PSID data. Cagetti and De Nardi (2006) use a perpetual youth model with bequest and intergenerational ability transfers to match the 33% shares held by the top one percent of the US population. These two papers implicitly rely on the dynastic nature of wealth accumulation to help match the US data. The present paper abstracts from these mechanisms and takes a closer look at the potential of the behaviorally accumulated business experience to analyze wealth and income inequality over the life cycle.

[17]While I acknowledge the importance of those mechanisms, one could view this exercise as an extension of Huggett (1996)'s model with entrepreneurship and human capital accumulation. In this way, the current model does a better job in terms of top wealth shares as compared to those in Huggett (1996).

Table 1.7: Wealth and Income distribution

	Top percentiles					
	1%	5%	10%	20%	30%	Gini index
Wealth						
Model (Human cap.)	23	54	70	86	94	**0.82**
Model (no Human cap.)	28	55	70	85	93	**0.82**
SCF	33	59	72	85	91	0.81
Income						
Model (Human cap.)	**20**	37	48	63	71	0.56
Model (no Human cap)	**21**	36	48	63	72	0.53
SCF	20	34	44	59	70	0.55

Note: SCF data are from the Survey of Consumer Finance 2010 survey. Numbers in bold are targeted in the benchmark economy.

be entrepreneurs is important on its own. However, the marginal contribution of entrepreneurial experience can be emphasized with respect to non-targeted data moments.

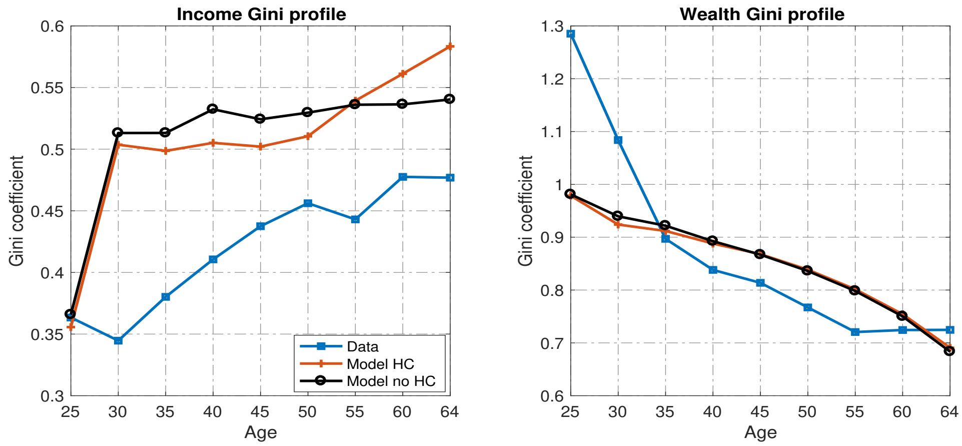
Table 1.8: Entrepreneurs and the distribution of wealth (non targeted)

	Fraction of entrepreneurs				Es' share of net worth			
Wealth percentile	1%	5%	10%	20%	1%	5%	10%	20%
Model	42	34	29	24	41	36	34	31
Model (no Human cap)	33	28	26	22	34	30	28	27
Data	54	39	32	22	61	53	48	41

Data are from Cagetti and De Nardi (2006).

Table 1.8 then shows the non-targeted distribution of entrepreneurs across the wealth percentiles and entrepreneurs' share of net worth held in a given percentile as well. The model with the *learning-by-doing* channel does rather a good job in matching the data counterpart. For instance, adding the accumulation of entrepreneurial experience into the model increases the fraction of entrepreneurs in the top 1% of wealth distribution by 9 percentage-point and their share of wealth by 7 percentage point. I therefore argue that the future rewards of human capital if entrepreneur sustains his position long enough in the business sector is quantitatively important in generating realistic dispersion among entrepreneurs.[18] To the extent that entrepreneurs have a higher saving rate than workers, a good representation of their fraction among top wealth percentiles gives confidence in the model capacity to highlight capital formation in the economy.

Figure 1.5: Gini profiles

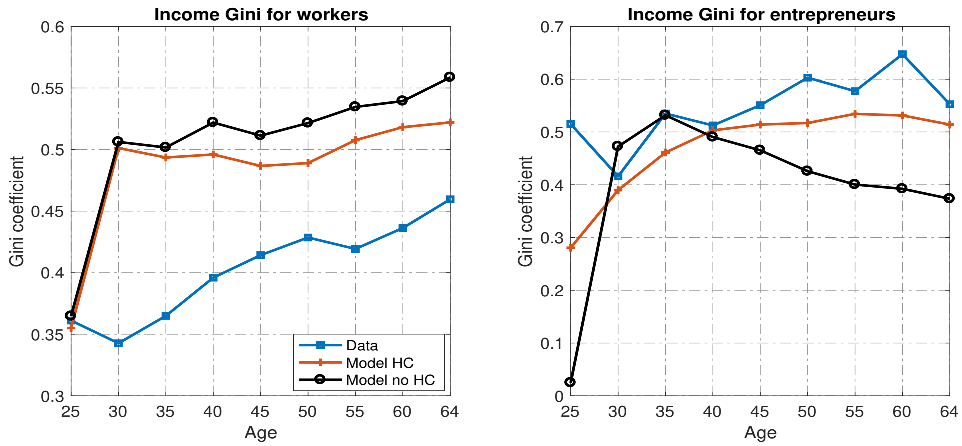


To see how inequality evolves over life, I depict the wealth and income Gini coefficients in figure 1.5. The data pattern (blue line) shows that wealth inequality is higher for young and decreases as they age. This is also documented in Huggett (1996) and Hendricks (2007) . One rationale for this is the fact that with their increasing labor or business income agents are able to increase their savings for precautionary motives during working life. And because during retirement period, there is no longer idiosyncratic shocks individuals rely mainly on smoothed retirement consumption which reduces wealth inequality. Both models are consistent with data but start with a Gini coefficient lower than 1.00 since agents beggin their life with zero asset while there is the possibility of negative net worth in the data. The first panel shows that inequality with respect to income is also consistent with empirical counterpart provided that the Gini coefficient is increasing with age. Recall that the life-cycle earning profile is hump-shaped then individuals earn more as they age. With high return on business experience at old age, income inequality is more pronounced.

The patterns in figure 1.5 do not show the inequality conditional on the occupation.

[18]This mechanism is an alternative way of considering accumulation of intangible capital. Bhandari and McGrattan (2018) document that *sweat equity* is as important as fixed capital used by private-held businesses in the US. Therefore, defining *sweat equity* as the value of time to build customer bases, client lists, and other intangible assets, they find an aggregate sweat equity value of 0.65 times the GDP.

Figure 1.6: Income Gini profiles by occupation



Accordingly figure 1.6 decomposes these trends by occupation. The first panel emphasizes that although the two models present a similar shape as the data, the inequality is relatively higher in the model without human capital. Since this model requires higher labor productivity to match the data aggregate wealth Gini, larger inequality is present in this setup among workers. The second panels confirms that business experience provides a consistent fit to the data for entrepreneurs.

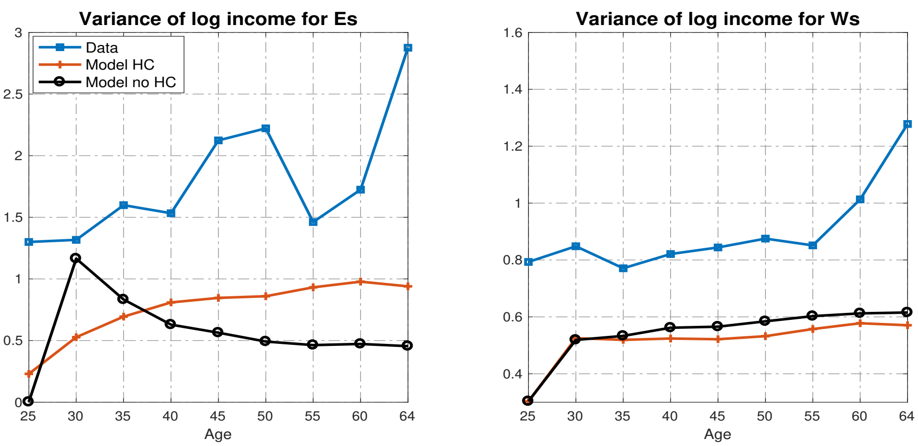
1.5.3 *Income dispersion by occupation*

Dispersion in income or earnings give another dimension to describe inequality between individuals. I rely in this section on the variance of *log* income and the percentile ratios. Figure 1.7 shows an upward sloping pattern in the income variability. In fact, as individuals age they face higher variability given that their working earning increases over their lifespan. In a broader way, idiosyncratic shocks coupled with human capital generate the disparity amongt agents over the life cycle .[19] The first panel sheds light on the net contribution of the endogenous business experience in the business income dispersion relative to the alternative model. The contributionof business experience (difference between the red line and the black line) increases up to 0.5 percentage point near retirement. Absent accumulation and valuation of entrepreneurial experience, the model displays a decreasing pattern after age 30, which is not supported by the data. On the

[19]Similar trends over the life cycle are supported in the literature. See for instance Huggett et al. (2011), Heathcote et al. (2010) and Kaplan(2012).

other hand, the model without business experience generates higher dispersion over the lifespan of individuals than the alternative model in paid-work sector, above all when agents reach their forties (second panel).

Figure 1.7: Variance of log income



Next, I analyse the extent of inequality at the bottom and the top of income distribution by occupation. For ease in the exposition, I drop the age dimension and focus on the log of percentiles ratio: log 90/50 ratio for the top and log 50/10 for the bottom.[20] The third ratio log 90/10 shows how far the the 90^{th} percentiles is with respect to the bottom 10^{th} percentile. It is equal to the sum of the two previous log ratios.

Table 1.9 summarizes the dispersion averages of the previous inequality metrics and allows a quicker appreciation on the extent of inequality discussed in this paper. First, one can notice higher inequality within occupation irrespective of the metric. For instance, if the worker moves from the 10th percentile to the 50th or median, his income will experience 117%, 55% and 66% increase in income in the data, model with human capital and in the model without human capital, respectively. A relative higher magnitude applies to the case of entrepreneurs. Second, the difference between the top and the bottom of the income distribution is due to an increase in the bottom half of the distribution in the data (log 50/10), but is reversed in the two models. In fact, the PSID data oversample low-income households. The presence of entrepreneurship in both model induces agents

[20]I acknowledge that the 90/50 ratio gives a broader measure of the top earners groups, but the conclusion is reminiscent to that pointed out by the literature focused on top 1% or top 0.1% inequality as in Kindermann and Krueger (2014), Cagetti and De Nardi (2006), Quadrini (2000), among others. The main message is that the (finer) upper tail is a key driver in the income and wealth inequality in the US.

Table 1.9: Dispersion averages by occupation

	log 50/10	log 90/50	log 90/10	var(log income)
Workers				
Data	1.17	0.89	2.06	0.86
Model (Human cap.)	0.55	1.35	1.90	0.51
Model (no Human cap.)	0.66	1.33	1.98	0.54
Entrepreneurs				
Data	1.58	1.25	2.81	1.83
Model (Human cap)	1.20	1.43	2.63	0.91
Model (no Human cap)	0.86	0.91	1.77	0.50

Note: Data are from PSID (1968-2011). Moments are computed for each age-year cell and then averaged over all years. Only working people aged 20-64 are both considered in the models and the data.

to save more making the top half a driver of the inequality. Third, the variance of *log* income shows that there is twofold dispersion between workers and entrepreneurs in the data and in the model with business experience (1.83/0.86 and 0.91/0.51, respectively). The model without human capital displays as much dispersion for worker as for entrepreneurs(0.50/0.54). Overall, the introduction of the entrepreneurial-specific human capital channel brings the model close to the empirical findings. The contribution of occupational specific human capital in explaining the large dispersion in income is in line with findings in Kambourov and Manovskii (2009) where the focus is the dispersion of wage within and between occupations.

1.5.4 *Income dispersion and mobility*

An important feature in occupational model is the possibility for individuals to switch occupations at any period, making the analysis of the mobility noteworthy. Provided there are two occupations, I define as a *stayer* an agent who stays in the same occupation from one period to the next, namely work to work *(W-to-W)* or entrepreneurship to entrepreneurship *(E-to-E)*. Otherwise, a *switcher* changes his occupation either from work to entrepreneurship *(W-to-E)* or form entrepreneurship to work *(E-to-W)*. Table 1.10 summarizes the dispersion averages with respect to the mobility within and across occupations. This table sheds more light on what happens to individuals' income when they switch from one occupation to another. Work-stayers experience the lesser inequality in the data irrespective of the dispersion metric. This holds also for the two models with the human capital model being the closest to empirical counterparts. However, the bottom-half of work-stayers has the most dispersion in the data than in the model: a work-stayer moving to the median of the income distribution from the 10th percentile sees his income increases by 110% in the data meanwhile models predict 56% and 67%. If one considers entrepreneurship-stayers, it is readily clear that their income dispersions are in all cells greater than that of the staying workers, both for in the data and the model with business experience. But this does not hold true in the alternative model with no valuation of experience. On average, an individual staying in entrepreneurship will experience a twofold variability in his income as compare to the work-stayer's case (1.92/0.85). When looking at the occupation switchers, one notices that the mobility between occupations generates much dispersion than the within-mobility, and the extent is larger for the human capital model relative to the alternative one. This suggests that the occupational choice and the cumulative business experience have predictive power in the level of inequality observed in the data (and in the models too).[21]

Taking stock of the table 1.10, I can highlight the following (*i*) occupation stayers experience smaller income dispersion than switchers, (*ii*) work-stayers have the lowest inequality and dispersion of income, (*iii*) entrepreneurs-stayers have as much inequality and income dispersion as switchers involving entrepreneurship, and (*iv*) the human capital model is closer to the data than the setup without endogenous accumulation of business experience.

[21]Using millions of U.S. tax administrative data, Guvenen et al. (2015) underscore similar results relative to job switchers and job stayers. They also extended their analysis by using other higher moments such as kurtosis and skewness.

Table 1.10: Dispersion averages by occupation mobility

	log 50/10	log 90/50	log 90/10	var(log income)	Contribution(%)
Stayers					
W-to-W					
Data	1.10	0.86	1.96	0.85	100
Model (HC)	0.56	1.34	1.89	0.59	69.4
Model (no HC)	0.67	1.31	1.98	0.62	72.9
E-to-E					
Data	1.47	1.20	2.67	1.92	100
Model (HC)	1.11	1.36	2.47	0.86	44.8
Model (no HC)	0.82	0.92	1.74	0.48	25.0
Switchers					
W-to-E					
Data	1.75	1.36	3.11	1.83	100
Model (HC)	0.90	1.49	2.39	0.82	44.8
Model (no HC)	0.83	0.85	1.67	0.51	27.9
E-to-W					
Data	1.39	1.27	2.66	1.72	100
Model (HC)	0.73	0.94	1.67	0.48	27.9
Model (no HC)	1.01	1.11	2.12	0.57	33.3

Note: Data are from PSID (1968-2011). An individual who stays in the same occupation from one period to the next is referred to as work to work (W-to-W) or entrepreneurship to entrepreneurship (E-to-E). On the other hand, if he changes his occupation either from work to entrepreneurship or form entrepreneurship to work, I used the terms (W-to-E) and (E-to-W), respectively. Moments are computed for each age-year cell and then averaged over all years. Only working people aged 20-64 are both considered in the models and the data. The contribution column reflects the extent of income variability explained by each model given the mobility sequence. Then one divides each model's variance by the data in the corresponding mobility direction. HC : Human capital or business experience.

1.6 Conclusion

As is shown in the literature, entrepreneurship motive is by its own an important culprit of wealth inequality, above all at the top income distribution in the U.S. economy. The findings in this paper emphasize the complementarity role of entrepreneurial-specific human capital as an important driver for wealth and income dispersion over the life cycle. The valuation of this implicit human capital relaxes the collateral constrained faced by would-be entrepreneurs and entrepreneurial households, reduces the exit rate from entrepreneurship, increases entry rate and then, sustains higher accumulation of wealth as compared to paid-workers. By this mechanism, individuals end up unequal over their lifespan with respect to different inequality metrics.

An interpretation of my findings is that inequality amongst individuals over their life-cycle has root in the way they change occupations and accumulate human capital. Therefore, policies seeking inequality reduction should focus on how to incentivize agents to enter entrepreneurship earlier in their working life. For instance, high tax progressivity and/or collateral constraint reduction may help drive down inequality.

As of December 2017, the US Congress passed a sweeping tax reform, known as Tax Cuts and Jobs Act (TCJA). Many debates have been triggered by this reform. Therefore, understanding the macroeconomics and distributional effects of personal and corporate tax cuts is a future research avenue. Moreover, entrepreneurship induces disparities between individuals and how their behavior affects the economy. Since entrepreneurs have higher saving rates and face collateral constraints in their sector, another future research would be to investigate if the planner is willing to propose separate tax schedules for the two occupations.

Chapter 2

The Tax Cuts and Jobs Act (TCJA): A Quantitative Evaluation of Key Provisions

2.1 Introduction

Recently, the US tax code went through a major overhaul with the enactment of the Tax Cuts and Jobs Act (TCJA).[1] The key feature of this reform is markedly the reduction of tax burden on businesses (corporate and non-corporate) as compared to workers. This paper provides a quantitative assessment of the macroeconomic and distributional effects of the TCJA.

The framework that I consider is a dynamic general equilibrium model of entrepreneurship built on Cagetti and De Nardi (2006), modified to feature a life-cycle dynamics. While households age and save for life-cycle purpose and retirement, they can invest in active businesses in a financially constrained environment. The possible switch between paid work and entrepreneurship makes their saving behavior tied to the endogenous nature of occupational choice. The need to overcome borrowing constraints to start up or to scale up a venture provides another reason for high saving rate for would-be entrepreneurs and entrepreneurial households. Furthermore, when households undertake a spell in the business sector they acquire an entrepreneurial experience which is essen-

[1] President Trump just signed into law the Tax Cuts and Jobs Act (TCJA) on December 22, 2017. This bill is considered as a major re-write of the US tax code since the last three decades after the Tax Reform Act of 1986.

tial in the subsequent business success. Therefore, they keep saving even more. This mechanism is also important to account for the existence of serial entrepreneurs found in the data.

The TCJA is modeled by its three key provisions: a new 20-percent-deduction rate for pass-throughs,[2] a drop in the statutory tax rate for corporations from 35% to 21% and the reduction to 37% of the top marginal tax rate for individuals from 39.6%. One important aspect of this law is the fact that, tax cuts for individuals and pass-through businesses are temporary - with a sunset clause set for 2025 - while corporate tax cut is permanent. Therefore, the long-run effects of TCJA are primarily driven by the reduction of the corporate tax rate, while the short-run effects combine different features of the tax reform. All assessments of the tax reform in the current paper are performed assuming revenue neutrality.[3]

Under the TCJA, the economy experiences on average, a GDP growth rate of 0.90% over a ten-year window and capital stock increases by 2.12%. Entrepreneurial sector shrinks by 0.5%. The temporary feature of the tax cuts for individuals and unincorporated businesses dampens the TCJA's long-run effects provided that output, capital stock and entrepreneurship rise only by 0.63%, 1.25% and 3%, respectively. Nonetheless, when the TCJA is implemented without any scheduled expiration the economy displays 3% increase in output and 7.6% in capital stock in the long run, mainly due to the new 20-percent-deduction provision. In this scenario, entrepreneurship is higher by 2%.

The incentives stemming from the business income deduction's provision are the main driver of the TCJA when all three provisions are made permanent. They contribute to more than 70% to the increase in output and capital stock. The interest rate goes down by 10% in this case, which is more than proportional to the rise of 2.3% in wage rate. Thus, the financial constraints are alleviated for would-be entrepreneurs making the outside option as a worker less attractive (positive extensive margin). For instance, entrepreneurial population and entry rate increase by 3% while the exit rate is reduced by 2%. Moreover, the existing business owners take advantage of the tax break to scale

[2]There are two main legal form of organizations for businesses in the US: Pass-throughs and C-corporations. Pass-throughs' profits flow directly to their owners' income and are treated as individual income by the IRS. They are composed of Sole proprietorships, Partnerships, and S-corporations. Altogether the represent more than 90% of businesses in the US. C-corporations face double taxation: first on operating income at the firm level, then on dividends paid out to shareholders.

[3]However for comparison, I relax this year-by-year assumption by allowing revenue neutrality over the ten-year window analysis. This is standard in federal agencies' analysis such as that of the Joint Committee on Taxation.

up their investment. The average firm size then increases (positive intensive margin). The two effects complement each other inducing the economy to experience higher savings and output. On the other hand, allowing all provisions but not the corporate tax to expire makes macroeconomic aggregates to return to their baseline level. In the long-run and from a purely efficiency perspective, there is a net advantage of extending all provisions since all aggregates experience positive growth rates.

I find that economic inequality is higher under the TCJA with permanent provisions. The Gini coefficients for income and wealth increase by 0.02% and 1.25%, respectively. Provided the TJCA is top and business-oriented; typically, only those entrepreneurs at the top really take advantage of the new provisions making them save more than the rest of the population. Thus, inequality goes up. Moreover, the reform generates large heterogeneity within and between occupations. While variance in consumption on average is higher in the reformed economy, that of the disposable income and asset are lower almost for all workers (namely, those outside the top 10th decile). Indeed, the large increase in income and asset dispersion for the top decile workers (dominant effect of the top marginal tax cut) drives up higher variability in consumption for all workers. Therefore with more disposable income, inequality in consumption rises. The three dispersion measures rise among entrepreneurs. Having to paid lower tax liabilities, top entrepreneurs hold higher income, save and consume more than the remaining business owners, which amplifies the within inequality. As a result, the TCJA induces higher dispersion in the economy.

To the extent that the business deduction's provision drives mainly the TCJA's effect when all provisions are extended, I argue that the new 20% deduction exhacerbates the initial inequality already presents among business owners. Wealthier entrepreneurs are getting simply wealthier. The welfare consequences are opposite for the two occupations. In fact, on average, entrepreneurs are better off while workers experience welfare loss even with a wage increase of 3%. The revenue-neutral condition wipes out the potential tax relief contained in the reform. Accordingly, the whole population suffers a consumption loss relatively to the *status quo* accounting for the transitional dynamics. On the welfare basis, the TCJA does not have a majority support.[4] These results hold regardless of the sunset clause for certain provisions of the TCJA.

[4]The majority of Americans were against this reform according to different polls. Particularly, the Pew Research Center finds at least 52% were opposed to the bill. See http://www.pewresearch.org/fact-tank/2017/09/27/more-americans-favor-raising-than-lowering-tax-rates-on-corporations-high-household-incomes/

Related literature. This paper is related to the large strand of literature on the quantitative evaluation of tax reforms using macroeconomic models. A first set of studies carries out hypothetical tax reform. Castaneda et al. (2003) show that abolishing estate tax will generates an output growth of 0.35%. Looking at the welfare consequences during transition, Domeij and Heathcote (2004) study the effect of removing capital taxation both in representative agent model and Aiyagari-type models. A second set of papers also performs thought experiment in occupational choice model where agents can choose paid-work or running a business. Cagetti and De Nardi (2009) then discuss the effect of repealing estate taxation on wealth distribution in this environment. Meh (2008) emphasizes the positive effects of the elimination of corporate tax rate. In presence of idiosyncratic investment risk, Panousi (2012) finds positive effect of capital taxation. Using a dynastic model, Kitao (2008) analyzes the incentives when capital income is reduced and also when business income is preferentially taxed with a flat tax rate. In the same vein, Bohácek and Zubrický (2012), examine a flat tax reform with different exemption levels in entrepreneurship model. A recent paper by Kaymak and Poschke (2016), analyzes the historical changes in the actual tax and transfer system, combined with those in the wage distribution, and focuses on the rise in wealth inequality over half a century in the US. In this paper, I evaluate key provisions of the TCJA.

Barro and Furman (2018) use a standard neoclassical framework with infinitely lived agents, and perfect foresight to evaluate the effects of the TCJA through the user cost approach. Sedláček and Sterk (2019) extend Barro and Furman (2018)' work by using heterogenous firms setup.[5] On the other hand, the current paper allows agents to be affected by earnings shocks and choose their optimal occupation over their lifecycle. It also carries out distributional and welfare analysis which is absent from Barro and Furman (2018) and Sedláček and Sterk (2019). The extended institutional details of the new tax law are more closely followed by the analyses of U.S. federal agencies such as the Joint Committee on Taxation (JCT, 2017), the Congressional Budget Office (CBO, 2018) and the Penn Wharton Budget model (PWBM, 2018), I therefore see the current analysis as a complementary one since the results lie in the same ranges.

The interplay between entrepreneurship, macroeconomic aggregates (output, capital

[5]The main provision implemented in their paper is the corporate tax cut. The steady-state analysis of the corporate tax cut shows that the effects on output, employment and consumption are substantial, but as pointed out by Clementi (2019) the contribution of the enty and exit margins may be to large. Also Sedláček and Sterk (2019) do not consider the transitional dynamics, which makes their analysis not complete to clearly address entrepreneurial dynamics.

formation and prices) and inequality among households has been stressed in the literature (Quadrini, 2000; Gentry and Hubbard, 2004; Cagetti and De Nardi, 2006; Buera, 2009). The framework here shares the same mechanism and adds a complementary entrepreneurial experience channel.

Furthermore, entrepreneurship can have a legal form of organization margin allowing business owners to elect their firms as pass-throughs or C-corporation for tax and financing purpose (Chen et al., 2017; Dyrda and Pugsley, 2018). I abstract from this channel in the current setup.

The layout is as follows. An illustrative exemple is given in section 2.2 to overview the direct effects of the new provision for entrepreneurs. The model and its recursive formulation are presented in section 2.3. Section 2.4 discusses model calibration. The evaluation of aggregate and distributional effects of the TCJA reform is carried out in section 2.5 and section 2.6 emphasizes its transitional dynamics and comparison with federal agencies' estimates. Section 2.7 concludes.

2.2 Illustrative exemple

In this section, I provide a simple example illustrating how individuals will be impacted by the new tax reform. Specifically, I focus on the new provision for entrepreneurial income: the new 20%-deduction provision. Under this provision entrepreneurs are now allowed to deduct 20% of their taxable income before submitting the remaining 80% to the regular tax schedule. Workers cannot take advantage of this provision. The Trump Administration argues that this is a good incentive for the business sector, namely the small businesses. In fact, with this provision they will be able to invest and hire more people. And eventually this will induce a Laffer curve effect on the whole economy.

However, the static analysis shown in table 2.1 displays an increase in the tax liability paid by the salaried worker relative to that of the entrepreneur for the same gross income. Let's consider two single high-earner : a wage earner and a self-employed (entrepreneur). They both earn $250,000 a year. If one proceeds with the income tax calculations as indicated in table 2.1, the entrepreneur receives $14,500 as tax subsidy while the worker must pay $150 in taxes. The selling argument of this tax reform is that *tax cuts* across the income board, but this argument might not be supported for all individuals, above all when individuals are single out based on their occupation or source of income.

Table 2.1: Single high-earner with wages or self-employment income

	With Wages		With Self-Employment Income	
	pre-TCJA Law	TCJA	pre-TCJA Law	TCJA
Adjusted gross income (AGI)	$250,000	$250,000	$ 250,000	$250,000
Personal exemptions	$4,150	$0	$4,150	$0
Itemized deductions	$46,000	$30,500	$46,000	$30,500
Taxable Income 1	$199,850	$219,500	$199,850	$219,500
Business income deduction (20%)	$0	$0	$0	$43,900
Taxable Income 2	$199,850	$219,500	$199,850	$175,600
Tax before credits and AMT	$49,021	$52,515	$49,021	$37,882
Alternative minimum tax (AMT)	$3,345	$0	$3,345	$0
Tax after credits and AMT	$52,366	$52,515	$52,366	$37,882
Tax cut(-) or Increase(+)		$149		-$14,485

Source: Urban-Brookings Tax Policy Center Microsimulation Model (version 0217-1).

This exemple highlights the importance of considering a set up where the occupation status can be clearly identified for the taxation purpose. The section below provides such a framework.

2.3 Model Economy

I build on Cagetti and De Nardi (2006) to allow individuals to choose occupation between paid work and entrepreneurship. However, the simple life-cycle structure in their model does not enable one to fully describe the transition in and out of entrepreneurship, therefore I adopt a life-cycle approach with lifetime uncertainty but without bequests. They work for the first R years followed by an inactive period of retirement. Individuals live J periods and start their life with zero initial wealth.

2.3.1 Demographics and preferences

The economy is inhabited by multiple cohorts of individuals of different ages. Each cohort is comprised of a continuum of measure one of individuals who live for a finite number of periods. Each period, an agent of age j decides whether to be an entrepreneur or a worker.

2.3.2 Technologies

Work productivity

Labor supply is inelastic. A worker earns a market wage w per efficiency unit of labor ϵ_j, where ϵ_j denotes an age-specific productivity, which captures the average wage between workers of different age, and evolves deterministically along the life-cycle. Workers are also subject to idiosyncratic shocks, η, that are distributed according to the following stochastic AR(1) process.

$$\ln\eta_t = \rho\ln\eta_{t-1} + \epsilon_{\eta,t} \text{ where } \qquad \epsilon_{\eta,t} \sim N(0,\sigma_\eta^2)$$

Cumulative business experience and entrepreneurial production

The more time an agent spends in the business sector, the more productive he becomes as an entrepreneur experience rises, making the entrepreneur's human capital an essential input for the business to succeed. I define business experience at any age j by the total number of years an agent has worked as an entrepreneur in their career. Formally, let $o(a,z,,\eta,j,\kappa) \in \{worker, entrepreneur\}$ denote the occupational choice given asset, abilities, age j, and entrepreneurial experience κ, the accumulation of this experience is as follows

$$\kappa' = \kappa + \mathbb{1}_{\{o(a,z,\eta,j,\kappa)=e\}}, \tag{2.1}$$

where

$$\mathbb{1} = \begin{cases} 1 & \text{if } o(a,z,\eta,j,\kappa) = entrepreneur \\ 0 & \text{otherwise} \end{cases} \tag{2.2}$$

The production technology available in the entrepreneurial sector is in line with the span-of-control assumption (Lucas Jr, 1978). The entrepreneur rents working capital k at interest rate r and labor input l at market wage w in a constrained financial market environment. Markets arrangement are such that, the entrepreneur is able to borrow only up to a fraction $\lambda \geq 1$ of his initial wealth. Capital depreciates at rate δ. To capture the risky nature of entrepreneurial activity, I consider a stochastic entrepreneurial ability z following a Markovian process. The effective entrepreneurial ability is defined as $z_e = z\kappa^\theta$, where $\theta \in (0,1)$ is the elasticity of the effective human capital with respect to experience. Therefore, the business income of the entrepreneur π is as follows

$$\pi(a,z,\kappa) = \max_{l\geq 0,\, k\leq \lambda a} z\kappa^\theta (k^\alpha l^{1-\alpha})^\gamma - \delta k - r(k-a) - wl \tag{2.3}$$

where $\alpha, \gamma, \in (0, 1)$.

Corporate sector:

Not all businesses in the economy are performed by individual entrepreneurs. There is also a group of relatively large and unconstrained firms which I refer to as C-corporations. I then suppose that these corporations are represented by a single corporate firm using a constant returns-to-scale production function.[6] To capture the effect of corporate taxation, the aggregate corporate firm pays a proportional corporate tax τ_c on its operating profit which is defined as production net of labor cost and capital depreciation.[7] The corporate firm then solves the following static problem which generates the rental price for capital and labor inputs:

$$\max_{K_c, L_c > 0} (1 - \tau_c) \underbrace{(A_c F(K_c, L_c) - \delta K_c - w L_c)}_{operating\ profit} - r K_c \tag{2.4}$$

First order conditions give rise to

$$r = (1 - \tau_c) \left[\alpha A_c \left(\frac{K_c}{L_c} \right)^{\alpha - 1} - \delta \right] \tag{2.5}$$

$$w = (1 - \alpha) A_c \left(\frac{K_c}{L_c} \right)^{\alpha} \tag{2.6}$$

Equation 4.33 highlights the impact of the corporate tax rate on the return to risk-free asset which can be thought of as return on corporate dividends held by agents in the economy. Therefore, the lower the corporate tax rate, the higher the return on these dividends and the higher the incentive to invest in risk-free assets instead of operating (pass-through) businesses.

[6] Although the corporate sector is not heterogenous and the legal form margin is absent in the current setup, this sector's size is still an endogenous object. Indeed, a positive selection of individuals into entrepreneurship reduces the corporate sector while a negative selection will increase it. I acknowledge that this is an imperfect way of capturing the legal form of organization margin emphasized by Dyrda and Pugsley (2018) and Chen et al. (2017).

[7] Indeed, operating profit is expressed as $\tilde{\pi} = A_c K_c^{\alpha} L_c^{1-\alpha} - \delta K_c - w L_c$. One can then show that the corporate tax revenue $\tau_c \tilde{\pi} = \tau_c \tilde{r} K_c$. Thus, the before-corporate tax is given by $\tilde{r} = r/(1 - \tau_c)$.

2.3.3 Government and tax system

Government levies proportional taxes on consumption(sales tax) $T_s = \tau_s C$, progressive taxes on personal income T_y and uses the proceeds to finance an exogenous outlay G and retirement benefits, B. I consider the below tax scheme on income.

$$y^d = \xi \min\{y_{top}, y\}^{1-\tau} + (1 - \tau_{\max}) \max\{0, y - y_{top}\} \tag{2.7}$$

$$t(y) = y - y^d \tag{2.8}$$

where y^d is agent's disposable income, y the total income and $t(y)$ the amount of tax collected. The first term in equation 3.8 captures the progressivity of the U.S. personal income tax which can be approximated by a log-linear function outside the top income bracket[8] (Benabou, 2002; Heathcote et al., 2014a; Bakış et al., 2015). The second term represents the tax liabilities of those individuals in the top end of income distribution with $\tau_{\max}$ the top marginal tax rate (Kaymak and Poschke, 2016). The income level y_b is the critical level equalizing the marginal tax rates. That is, $1 - \xi(1-\tau) y_{top}^{-\tau} = \tau_{\max}$. The tax system progressivity is captured by τ. Accordingly, if $0 < \tau < 1$ taxation is progressive, meaning an increase in marginal tax with respect to income. A regressive schedule on the other hand, occurs when $\tau < 0$. The parameter ξ in equation 3.8 controls for the average level of taxation in the economy and it also allows one to balance government's budget at the equilibrium. Each period government's budget balances as

$$G + B = T_s + T_y + \tau_c \tilde{r} K_c \tag{2.9}$$

2.3.4 Recursive formulation

Agent of age j maximizes the expected flow of utility expressed in equation (4.4). I assume no aggregate uncertainty and prices are constant in the steady state.

$$\mathbb{E}_0 \left[\sum_{j=1}^{J} \beta^{j-1} u(c_j) \right] \tag{2.10}$$

where $u(c_j) = \frac{c_j^{1-\sigma}}{1-\sigma}$ where σ is the rate of relative risk aversion. Agent discounts future at rate $\beta \in (0, 1)$.

[8] This tax schedule rules out lump-sum transfers but allows agents to receive tax rebates or transfers as long as their total income $y \in (0, \xi^{\frac{1}{\tau}})$.

Each period, an age-j individual starts with an initial wealth a, productivity η, entrepreneurial ability z and experience κ, and then chooses his current occupation. Workers earn income from labor, make consumption and and savings decision. Entrepreneurs choose the working capital and labor input demand subject to the collateral constraint. Moreover, the entrepreneur gains one period of experience which will be essential in his subsequent ventures.

Agent's problem

a-Retiree's problem

After retirement, agents live off their savings and retirement benefits (b). Pension are paid out to any retiree regardless of his pre-retirement occupation. The problem of a retired agent for ages $j \in \{R, R+1, \ldots, J\}$ is given by

$$v_j(a) = \max_{a'} \left\{ u(c) + \beta v_{j+1}(a') \right\} \tag{Pr}$$

$$y_r = ra + b \tag{2.11}$$

$$(1+\tau_s)c + a' = y^d(y_r) + a \tag{2.12}$$

$$a \geq 0 \tag{2.13}$$

$$v_{J+1}(a) = 0 \tag{2.14}$$

Thus, during the retirement agent just chooses his next period asset holdings. To the extent that the agent's lifetime ends at J, equation 3.14 gives the one period ahead terminal utility which is zero. Recall that $y^d(.)$ is the net-of-tax schedule given in 3.8.

b-Working agent's problem

Before retirement, any agent in the economy has the following choice:

$$v_j(a, z, \eta, \kappa) = \max \left\{ v_j^w(a, z, \eta, \kappa), v_j^e(a, z, \eta, \kappa) \right\} \tag{2.15}$$

where $v_j^w(a, z, \eta, \kappa)$ and $v_j^e(a, z, \eta, \kappa)$ are the value functions of worker and entrepreneur, respectively.

b1-Worker's problem

Conditional on being on the labor market, an age-j worker solves the following recursive problem by choosing next savings and occupation.

$$v_j^w(a,z,\eta,\kappa) = \max_{a'} \left\{ u(c) + \beta \sum_{z',\eta'} \psi(z',\eta'|z,\eta) v_{j+1}(a',z',\eta',\kappa') \right\} \tag{Pw}$$

subject to

$$y_w = w\eta\epsilon_j + ra \tag{2.16}$$

$$(1+\tau_s)c + a' = y^d(y_w) + a \tag{2.17}$$

$$\kappa' = \kappa \tag{2.18}$$

$$a \geq 0, \quad j = 1, 2, \ldots, R-1 \tag{2.19}$$

The expectation is taken with respect to the underlying Markovian productivity distribution $\psi(z',\eta'|z,\eta)$ for the two abilities with the assumption that they are not correlated.[9] The worker's income stems from efficiency unit of labor per market wage. The budget constraint in (3.17) states that although the agent is bestowed with a given entrepreneurial productivity z, his current income does not depend on this productivity because he has chosen to be a paid-worker. Provided that a worker does not carry out production technology for his own, he does not accumulate this specific entrepreneurial experience.[10] The equation 3.18 then shows the static accumulation of entrepreneurial skill.

b2-Entrepreneur's problem

The recursive problem of an entrepreneur is now stated as follows

$$v_j^e(a,z,\eta,\kappa) = \max_{a'} \left\{ u(c) + \beta \sum_{z',\eta'} \psi(z',\eta'|z,\eta) v_{j+1}(a',z',\eta',\kappa') \right\} \tag{Pe}$$

[9]This assumption is also made in Cagetti and De Nardi (2006). They compute a robustness check with correlated abilities but results are not affected.

[10]One could possibly think of a similar occupation-specific human capital accumulated in paid-work sector. This extension not only will increase the computation burden but also will not change the intuition carried over by the current setup. Indeed, one could take the relative of the two human capital and then normalize the paid-working one rendering models equivalent. On the other hand, one could also argue that, since the model explicitly keeps of track the labor efficiency unit, the human capital in the paid-work sector is somehow taken into account.

subject to (3.4)-(1.7), (3.19) and

$$y_e = \pi(a, z, \kappa) \tag{2.20}$$

$$(1+\tau_s)c + a' = y^d(y_e) + a \tag{2.21}$$

$$\kappa' = \kappa + 1 \tag{2.22}$$

The main differences between the two occupations are the income earned in the current period and the accumulated entrepreneurial experience. In fact, the profit function $\pi(.)$ is a complex function which incorporates the borrowing constraints faced by the entrepreneur as described in section 3.2.2. The occupation-specific human capital gained in the business sector is defined in Eq (3.22) and translates the *learning-by-doing* process embedded in entrepreneurship. Hence, it is a latent variable behaviorally determined.

Equilibrium

At each point in time, individuals differ from one another with respect to age j and to state $s = (a, z, \eta, \kappa, o)$ i.e. asset holdings a, entrepreneurial productivity z, work productivity η, entrepreneurial experience κ and occupation $o \in \{W, E, Retiree\}$. Let $a \in \mathbb{A} = \mathbb{R}_+, z \in \mathbb{Z}, \eta \in \mathbb{H}, \kappa \in \mathbb{K}$ and $o \in \mathbb{O}$, and $\mathbb{S} = \mathbb{A} \times \mathbb{Z} \times \mathbb{H} \times \mathbb{K} \times \mathbb{O}$ the entire state space. Let $(\mathbb{S}, \mathcal{F}(\mathbb{S}), \phi j)$ be a space of probability, where $\mathcal{F}(\mathbb{S})$ is the Borel σ-algebra on $\mathbb{S}$: for each $\mathcal{B} \subset \mathcal{F}(\mathbb{S})$, $\phi_j(\mathcal{B})$ denotes the fraction of agents aged j that are in $\mathcal{B}$. Given the age j distribution ϕ_j, $Q_j(s, \mathcal{B})$ induces the age $j+1$ distribution ϕ_{j+1} as follows. The function $Q_j(s, \mathcal{B})$ determines the probability of an agent at age j and state s to transit to the set $\mathcal{B}$ at age $j+1$. The policy function for savings, consumption, entrepreneurial capital and entrepreneurial labor is given by $g_j^a(s), g_j^c(s), k_j(s)$ and $l_j(s)$, respectively.

Definition . Given a tax structure $\{\tau_s, \tau_c, \tau_I, \tau_{max}, \varphi, \xi, b\}$, a stationary recursive competitive equilibrium is a set of **functions** $\{v_j^w, v_j^e, v_j, g_j^a, g_j^c, k_j, l_j(s)\}_{j=1}^J$, and **prices** $\{\tilde{r}, w\}$ such that

(i) given prices, the functions solve the household problem in (Pw), (Pe) and (3.15);

(ii) the prices satisfy the marginal productivity conditions i.e. $\tilde{r} = F_{K_c}(K_c, L_c) - \varphi\delta$ and $w = F_{L_c}(K_c, L_c)$;

(iii) capital and labor markets clear :

$$\sum_{j=1}^{R-1}\int_{\mathbb{S}} k_j(s)d\phi_j + K_c = \sum_{j=1}^{J}\int_{\mathbb{S}} g_j^a(s)d\phi_j$$

$$\sum_{j=1}^{R-1}\int_{\mathbb{S}} l_j(s)d\phi_j + L_c = \sum_{j=1}^{R-1}\int_{\mathbb{S}} \epsilon_j\eta d\phi_j$$

(iv) given the decision rules, $\phi_j(s)$ follows the law of motion:

$$\phi_{j+1}(\mathcal{B}) = \int_{\mathbb{S}} Q_j(s,\mathcal{B})d\phi_j, \forall\mathcal{B}\subset\mathcal{F}(\mathbb{S});$$

(v) the government balances its budget:

$$G + B = \tau_c\left(\frac{r}{1-\tau_c}\right)K_c + \tau_s\sum_{j=1}^{J}\int_{\mathbb{S}} g_j^c(s)d\phi_j + \sum_{j=1}^{J}\int_{\mathbb{S}}[y_j - y_j^d]d\phi_j$$

where $y_j^d = \xi\min\{y_{top}, y_j\}^{1-\tau} + (1-\tau_{\max})\max\{0, y_j - y_{top}\} + \tau_d y_j^e \mathbb{1}_{\{occup=entrepreneur\}}$
$y_j = \mathbb{1}_{\{occup=worker\}}y_j^w + \mathbb{1}_{\{occup=entrepreneur\}}(1-\tau_d)y_j^e + \mathbb{1}_{\{Retiree\}}y_j^r$
and τ_d is the deduction rate for entrepreneurs.

2.4 Calibration

In this section I discuss the parametrization of the model economy. The calibration procedure is then carried out in two steps: I first fix a set of parameters drawn upon the literature (table 2.2) and then I jointly calibrate the remaining parameters so that the model economy is consistent with a set of aggregate statistics of the U.S. economy (table 2.4). I use the PSID (1968-2011) and the SCF (2010) to compute some relevant statistics.

Table 2.2: Fixed parameters

Parameter	Symbol	Value	Source
Preferences, demographics and technology			
Risk aversion	σ	2.0	Conesa et al. (2009)
Lifetime	J	61.0	Average US data
Retirement	R	46.0	Average US data
Corporate capital income share	α	0.33	Gollin (2002)
Depreciation rate	δ	0.06	Stokey and Rebelo (1995)
Technology parameter	A_c	1.00	Normalization
Borrowing limit	λ	1.50	Kitao (2008)
Labor productivity			
productivity and process	η, P_η	–	Storesletten et al. (2004)
Age-dependent efficiency unit	$\{\epsilon_j\}$	–	own estimate using PSID
Government			
Government spending	G/Y	0.17	Conesa et al. (2009)
Replacement rate	τ_{rep}	0.40	Kotlikoff et al. (1999)
Consumption tax	τ_s	0.05	Imrohoroglu and Kitao (2010)
Tax progressivity	τ	0.17	Bakış et al. (2015)
Top marginal tax	$\tau_{\max}$	0.396	US data
Deduction rate for entrepreneurs	τ_d	0.00	US data
Average effective corporate tax rate	τ_c	0.29	Gravelle (2014)

2.4.1 *Preferences*

The relative risk aversion parameter σ is set to 2 following Conesa et al. (2009). The subjective discount factor β is jointly set to 0.951 so that, in equilibrium, the capital-output ratio is 2.65.

2.4.2 *Demographics and endowments*

Individuals enter the economy at real age 20 (model period 1) and live up to a maximum age of 80 years (model period $J = 61$). Since the mandatory retirement age in the US is 65, I allow agents to work until model period 45 and then retire at $R = 46$. Agents are endowed with one unit of time which they supply inelastically irrespective of the occupation.

Labor efficiency unit $\{\epsilon_j\}$ are computed using hourly earnings from the PSID and are intended to capture the standard hump-shape of the cross-sectional earnings profile. Earnings increase with age and during the prime-age, but start declining after retirement. The idiosyncratic shock η takes on six possible values $\eta \in (\eta_1, \eta_2, \eta_3, \eta_4, \eta_5, \eta_6)$ where the first five are computed using an approximation of an AR(1) process after Tauchen (1986) as defined in section 3.2.2. Following estimations by Storesletten et al. (2004) I set the persistence coefficient ρ and the residual variance σ_η^2 to 0.95 and 0.03, respectively.[11]

However, the sixth productivity level η_6 is aimed at capturing an awesome state attainable with a small likelihood (Castaneda et al., 2003; Kaymak and Poschke, 2016). From any other state, η_6 can be reached with the same probability $\phi_{.6}$, but once individuals visit this state, they can only fall back to the medium ability η_3 with probability ϕ_{63}. Accordingly, one has to calibrate three parameters stemming from the workers' side : the two probabilities $\phi_{.6}$ and ϕ_{63}, and the awesome state η_6. The target data moments are the overall economy wealth Gini of 0.80, workers' total labor income Gini of 0.52 and the income share held by the top percentile of the income distribution which amounts to 20% in the (SCF, 2010).

On the other hand, entrepreneurial ability is defined by four different values $z \in \{z_1, z_2, z_3, z_4\}$. I set the first one to 0 so that any individual with this ability will always chose to be a worker. By introducing an average ability $\bar{z}$ and a deviation ability $\hat{z}$, I relate the four abilities as $\{z_1, z_2, z_3, z_4\} = \bar{z} * \{0, 1 - \hat{z}, 1, 1 + \hat{z}\}$, where $\hat{z} \in (0, 1)$, and therefore I am left with two abilities to calibrate. To ensure a parsimonious calibration of the transition probability P_z, I follow Kitao (2008) by assuming that agents can only move up and down to the closest state:

$$P_z = \begin{pmatrix} p_{11} & 1 - p_{11} & 0 & 0 \\ p_{21} & p_{22} & 1 - p_{21} - p_{22} & 0 \\ 0 & p_{32} & p_{33} & 1 - p_{32} - p_{33} \\ 0 & 0 & 1 - p_{44} & p_{44} \end{pmatrix}$$

The middle two rows probabilities are assumed to be identical, namely $p_{21} = p_{32}$ and $p_{22} = p_{33}$. I therefore calibrate the six parameters associated to the process of z, the span-of-control γ and the return to entrepreneurial human capital θ by matching eight targets in the steady state: the fraction of entrepreneurs in the economy, the average entry rate of workers into entrepreneurship, the average exit rate of entrepreneurs, the share of capital used in the entrepreneurial sector, the average tenure in the business sector, the share of income earned by entrepreneurs, the share of business income held by top entrepreneurs and the ratio of entrepreneurs' wealth-income ratio to that of workers over the life-cycle.

Using the definition of an entrepreneur as a self-employed business owner who ac-

[11] Using different models, Storesletten et al. (2004) find that ρ ranges from 0.94 to 0.96, and the variance lies between 0.014 and 0.04. I then take the average values of both estimates. This values are consistent with the range of estimates in the literature. For instance, $\rho = 0.94$ and $\sigma_\eta^2 = 0.016$ are found in Kaplan (2012).

tively manage his venture, Cagetti and De Nardi (2006) find 7.5% of the US population falls in this category. I target the same figure. If one relaxes this definition by defining an entrepreneur as self-employed or business owner, the fraction of entrepreneurs can increase up to 12% (Quadrini, 2000; Gentry and Hubbard, 2004). The annual average entry and exit rates are set to 2.5% and 20%, respectively using the PSID (1968-2011). These targets are close enough to the 2.3% and 22% in Cagetti and De Nardi (2006). To capture the split of the economy in two sectors : corporations and incorporate businesses; I set the entrepreneurial capital share to 35% as Quadrini (2000). The panel nature of the PSID allows one to compute the average years an individual stays in entrepreneurship, I find seven years on average and then use it as target. This data moment is clearly to help identify the contribution of the entrepreneurial experience channel.

Some aspects of the income property are also targeted. The model is required to match the share of income hold by entrepreneurs of 20%. In Quadrini (2000), 12% of the population are defined as entrepreneurs and hold 22% of the income, but the lower fraction of entrepreneurs in my model leads me to choose a lower target of 20% which is consistent with their income share of 19.4% in the SCF (2010). Further, to capture the heterogeneity in business income, I choose to target the 39,95% of business income held by top 1% earners found in the SCF. I discipline the model savings rate over the lifespan by targeting the relative ratio of entrepreneurs' wealth-income ratio to that of workers over the life cycle. On average, the wealth-income ratio is 11.15 for entrepreneurs and 3.21 for workers using the PSID. Therefore, the relative ratio of the two occupations' wealth-income ratio is 2.9. One rationale guiding this choice is to allow the model to capture the persistent inequality over the life cycle between the two occupations.

Table 2.3: Jointly calibrated parameters

Parameter	Symbol	Value
Labor productivity process		
higher productivity level	η_6	21.75
probability of reaching this state from anywhere	$\phi_{.6}$	0.003
Median-reverting probability	ϕ_{63}	0.128
Entrepreneurial ability process		
Entrepreneurial ability levels	$\bar{z}$	1.150
	$\hat{z}$	0.213
Transition probabilities	p_{11}	0.987
	p_{21}	0.487
	p_{22}	0.313
	p_{44}	0.702
Remaining parameters		
Discount factor	β	0.951
Span-of-control parameter	γ	0.830
Return to entrepreneurial experience	θ	0.236

2.4.3 *Technology and market arrangement*

In the corporate sector, the share of output that goes to the capital α is set to 0.33 as is standard in macro literature (Gollin, 2002). The productivity parameter A_c is normalized to unity. Capital depreciates in both sectors at the same rate δ which I fix to standard value of 6% (Stokey and Rebelo, 1995).

One important aspect of entrepreneurship if the existence of financial constraint that could prevent one from starting or expanding a venture. Empirical estimations such as Evans and Jovanovic (1989) have shown the relevance of such constraints.[12] The financial sector then allows entrepreneurs to borrow up to a fraction $\lambda = 1.5$ of their assets.

2.4.4 *Government and tax system*

Government consumption, G is set to 17% of the output following Conesa et al. (2009). The replacement rate for retirees is 40% of the average pre-retirement earnings (Kotlikoff

[12] The relevance of borrowing constraint is extensively used in quantitative macro models (Kitao, 2008; Buera, 2006, 2009), and references therein). However, Hurst and Lusardi (2004) challenged this view by arguing that borrowing constraints are non active for households below the 95% of the wealth distribution. Then the entry probability is only increasing with wealth for households in the top-end 5% of the wealth distribution.

et al., 1999). These expenditures are funded by sales and income tax proceeds. I fix the proportional consumption or sales tax τ_s to 5% (Imrohoroglu and Kitao, 2010). The income tax progressivity τ in US economy estimates from Bakış et al. (2015) and Heathcote et al. (2014a) lie between 17% to 18.5%. I use the lower bound of these estimates in the benchmark economy as in Bakış et al. (2015).

Table 2.4: Targets: Data and Model

	Data	**Model**
Capital-output ratio	2.650	2.600
Overall wealth Gini	0.810	0.820
Income Gini for workers	0.520	0.518
Income share for top earners	0.200	0.204
Fraction of Entrepreneurs	0.075	0.071
Entry rate into entrepreneurship	0.025	0.026
Exit rate from entrepreneurship	0.200	0.209
Average Tenure in Entrepreneurship	7.000	8.000
Fraction of total Capital used by Entrepreneurs	0.350	0.356
Business income share for top Entrepreneurs	0.400	0.370
Entrepneurs' share of Total income	0.200	0.208
Wealth-Income ratio (Entrepreneur to Worker)	3.000	2.750

2.4.5 Characteristics of the benchmark economy

The quantitative results of the baseline economy are presented in this section. Table 2.4 summarizes the performance of the model economy with respect to the data targets. Overall, the model has a good fit even though it overshoots in a small extent the income share for top earners and that of entrepreneurs. Some properties of the model can be reviewed.

Wealth and income inequality in the benchmark economy and its data counterpart are shown in table 2.5 where distributions are broken down into top 1% to top 30% shares. Recalling that the model in the calibration procedure does not explicitly target the wealth and income distribution, except for the overall wealth Gini. It is then the case that, the benchmark captures the contribution of entrepreneurial human capital among individuals over the life-cycle. The model misses mainly the top 1% in term of wealth shares.[13] Thus, there is more positive wealth skewness in the data than in the benchmark economy. This result is not surprising since entrepreneurship motive coupled with dynastic wealth accumulation and bequest are important ingredients to perfectly match data[14] (Quadrini, 2000; Cagetti and De Nardi, 2006).

Table 2.5: Wealth and Income distribution

	Top percentiles					
	1%	5%	10%	20%	30%	Gini index
Wealth						
Model	23	54	70	86	94	**0.82**
SCF	33	59	72	85	91	0.81
Income						
Model	**20**	37	48	63	71	0.56
SCF	20	34	44	59	70	0.55

Note: SCF data are from the 2010 survey. Numbers in bold are targeted in the benchmark economy.

Table 2.6: Fraction of Entrepreneurs by wealth percentile (non targeted)

	Top percentiles			
	1%	5%	10%	20%
Model	42	34	29	24
Data	54	39	32	22

Data are from Cagetti and De Nardi (2006).

Table 2.6 shows the non-targeted distribution of entrepreneurs across the wealth percentiles. The model does rather a good job in matching the data counterpart. The minor

[13] As is well-known in entrepreneurship and wealth dynamics literature, the entrepreneurship motive coupled with others channels can perfectly match the data. For instance, Quadrini (2000) in a dynastic Aiyagari-type model, shows that the high saving rates of entrepreneurs to overcome stringent borrowing constraints generates close wealth inequality with respect to PSID data. Cagetti and De Nardi (2006) use a perpetual youth model with bequest and intergenerational ability transfers to match the 33% wealth share held by the top one percent of the US population in the SCF. These two papers implicitly rely on the dynastic nature of wealth accumulation to help match the US data. The present paper abstracts from these mechanisms and takes a closer look at the potential of the behaviorally accumulated entrepreneurial human capital to explaining wealth and income inequality over the life-cycle.

[14] While I acknowledge the importance of those mechanisms, one could view this exercise as an extension of Huggett (1996)'s model with entrepreneurship and human capital accumulation. In this way, the current model does a better job in terms of top wealth shares as compared to those in Huggett (1996).

discrepancy may come from the wealth share's gap between the model and the data seen in table 2.5. To the extent that entrepreneurs have higher saving rate than workers, a good representation of their fraction among top wealth percentiles gives one layer of confidence in the model capacity to highlight capital formation in the economy.

Table 2.7: Tax Cuts and Job Act (TCJA): reform of 2017

Key provisions	All	Bus. deduction	Corp. cut	Top cut
Deduction for pass-throughs' income: $\tau_d^{bench} = 0\% \rightarrow \tau_d^{new} = 20\%$	X	X		
Corporate tax cut: $\tau_c^{bench} = 29\% \rightarrow \tau_c^{new} = 21\%$	X		X	
Top marginal tax cut: $\tau_{\max}^{bench} = 39.6\% \rightarrow \tau_{\max}^{new} = 37\%$	X			X

2.5 Effects of the TCJA: A long-run analysis

Since the Tax Reform Act of 1986, the Tax Cuts and Jobs Act is the major tax change in the U.S. tax code. Many important provisions are provided therein, but may be outside the scope of this paper.[15,16] Then, I retain as in table 2.7 three key provisions and highlight their contribution in explaining the overall effect of the TCJA.[17] However, in Appendix

[15]The full tax code has more than 1100 pages, please see here `http://docs.house.gov/billsthisweek/20171218/CRPT-115HRPT-466.pdf`. The tax cut for corporations is set to be permanent meanwhile tax cuts for individuals and pass-through businesses are temporary and must sunset by 2025.

[16]I should acknowledge that this paper does not explicitly consider some important aspects of the tax law such as investment expensing for equipment and structures as in Barro and Furman (2018), international provisions as in Congressional Budget Office(CBO), Joint Committee on Taxation (JCT) and the Wharton budget models. Also, even the application of the pass-through deduction here is simplified with respect to what the actual law prescribes. One can have a more accurate description in Gale and Krupkin (2018).

For instance, Barro and Furman (2018) use a standard neoclassical framework in a Ramsey-style set up with Cobb-Douglas production functions, infinitely lived agents, and perfect foresight to evaluate the effects of the TCJA. On the other hand, the current paper allows finitely lived agents to be affected by earnings shocks and choose their optimal occupation. It also carries out distributional and welfare analysis which is absent from Barro and Furman (2018). I then view my paper as a complementary analysis.

[17]As indicated in Appendix 4.7.2, there are small reductions in the marginal tax rates (MTR) for individuals. However, given the functional form of the progressive tax schedule in section 2.3.3, I focus on the reduction of the MTR for top earners. Since the itemized deduction for state and local income and property taxes is now limited to a total of $10,000, the effect of the small reduction of the marginal tax rates might be potentially dampened. Therefore, focusing primarily on the reduction of the MTR for the top earners (from 39.6$ to 37%) can be considered as a reasonable assumption.

4.7.2, I perform a sensibility analysis when some provisions are added with regard to the tax law as written.

As shown in the analysis of the transition in section 2.6, the economy will take around 30 to 40 years to reach the new steady state. The next subsection describes the responses of key macroeconomic variables, thereafter the economic inequality and welfare will be analyzed.

Table 2.8: Aggregate effects of the TCJA

		Key provisions of the TCJA			
Variables	Benchmark	**All**	**bus deduction**	**corp cut**	**top cut**
	Level	%Δ from benchmark			
Output	1.05	2.65	2.09	0.04	0.45
corporate	0.48	0.14	-2.34	1.63	1.34
non corporate	0.57	4.75	5.80	-1.30	-0.29
Capital	2.73	7.60	5.24	0.38	1.90
corporate	1.76	5.81	2.20	1.71	1.99
non corporate	0.97	10.82	10.73	-2.01	1.74
labor	0.49	-0.42	-0.63	0.14	0.18
corporate	0.25	-2.65	-4.60	1.59	1.01
non corporate	0.24	1.84	3.38	-1.32	-0.66
Prices					
after-corp-tax interest rate	2.33	-5.46	-12.46	+11.13	-2.01
wage	1.29	+2.85	+2.34	-0.02	+0.37
Corp. tax revenue/GDP (%)	1.59	1.01	1.39	1.17	1.58
Growth contribution of each provision (%)					
aggregate output	–	100	78.87	1.51	16.98
aggregate capital	–	100	68.95	5.00	25.00

2.5.1 *Aggregate effects*

The long run effect of the TCJA's provisions on key macroeconomic variables are reported in table 2.8. The last four columns implement the tax provisions as indicated in table 2.7. The new business income deduction and the top marginal tax cut have the same qualitative effect on capital formation and output, but differ in the amplitude and the mechanism. Indeed, a reduction of the top marginal tax rate lowers the after-tax return on savings (by -2%) since more income leads to more savings because it is taxed less. But the resulting increase in wage per efficiency (0.4%) is an impediment for would-be small business owners that might be constrained. As shown in Appendix 4.7.1, the entry rate falls. To the extent that not all entrepreneurs are in the upper-end income bracket to take advantage of this cut, the effect of savings on capital formation is small. On the other hand, the reduction of the taxable business income has a direct effect across the income spectrum, allowing even poor-income entrepreneurs to increase investment and output. The amplification effect kicks in given that entrepreneurs have on average higher saving rate relative to workers (Quadrini, 2000; Gentry and Hubbard, 2004; Cagetti and De Nardi, 2006). For instance, in the long run and conditional on extending all provisions, 80% the output growth rate is explained by the business income deduction's provision while the top tax cut only explains 17% of that growth. These proportions are reasonably constant if one considers the change in aggregate capital stock.[18]

To better understand the extent to which the tax cuts drive the results, I implement the experiments in partial equilibrium where prices are kept to their benchmark values. In fact, partial equilibrium captures the direct effects of the tax policy. From Annex 4.7.1, one sees that the tax cuts and factor prices adjustment have opposite effect. While tax cuts give more incentive for risk-taking activities in the business sector, giving rises to higher output and capital stock (positive effect); factor prices adjustment reduces these activities by making either investments or labor input costly for middle-class entrepreneurs whereby reducing the aggregates (negative effect). At the end, the positive incentive generated by the tax cut is enough to dominate the negative one stemming from the general equilibrium channel.

Nonetheless, the corporate tax cut has a zero-effect on aggregate output in the long run. Indeed, the after-tax interest rate rises and triggers two opposing effects : a fall in savings stemming from the reduction in the fraction of entrepreneurs which cancels out the increase in savings due to the higher interest rate, per se.[19] ,[20] Specifically, the hike by 11% of the after-tax interest rate increases the capital cost for entrepreneurs who reduce their investment by 2%. This reduction then leads to a drop in the entrepreneurial

[18]Note in table 2.7 that, the sum of changes in columns 3 through 5 does not equal the total change reported in the second column. This is potentially due to interactions between different provisions, when they are introduced together.

[19]This result is the opposite in Meh (2008) although both papers surprisingly find that, the reduction or the elimination of the corporate tax will reduce wealth inequality. In fact, the negative effect on savings due to lower entrepreneurship rate cancels out the positive effect of higher returns on savings in the current study. The capital accumulation is therefore lower than in his model.

[20]In the corporate tax cut scenario, given the setup of the corporate tax in the model in section 3.2.2, it is not possible to perform a partial equilibrium exercise because one cannot keep the benchmark factor prices values constant while changing the corporate tax. Even though, one cannot clearly disentangle the direct effect of the tax cut from the general equilibrium effect, two opposing forces are in play to explaining the final result.

output by 1.3%. The reallocation of the labor efficiency between the two sectors also captures the extension of the corporate sector and the shrinking of the non-corporate sector. For instance, a smaller entrepreneurial sector is now using 1.6% less efficiency labor from the benchmark while a growing corporate sector increases its by 1.3%. Thus, the expansion of the corporate sector as a result of a lower corporate tax rate is qualitatively consistent with the mechanism of legal form of organization outlined in Chen et al. (2017) and Dyrda and Pugsley (2018). Moreover, Barro and Furman (2018) using the user cost approach also find that the reduction of the corporate tax rate will boost corporate investment in the long run. In fact, the cut in the corporate taxe rate induces mechanically a lowering of the user cost of capital which creates incentives for corporations to acquired news equipment and structures assets. They underscore that corporate productivity (output per capita) is 2.5% higher relative to the baseline without tax change meanwhile that of pass-through businesses decreases by 0.8%.

When all the provisions are activated, the economy displays a 2.7% increase in output, 7.6% in capital stock, and aggregate labor efficiency unit decreases because the reallocation toward non-corporate sector dominates.[21] The business deduction's scenario dampens the after-tax interest hike brought about by the corporate tax cut. Accordingly, the overall effect of the TCJA is driven by this experiment. The last line outlines the importance of the corporate sector's tax revenue with respect to the aggregate output. As it comes with no surprise, the corporate tax cut shifts this burden toward individuals under revenue-neutral requirement, and generates 34% revenue less than in the benchmark.

2.5.2 Entrepreneurial dynamics

This section emphasizes the behavior of entrepreneurs, both in the extensive and intensive margin along the different provisions of the TCJA. This behavior helps understand the mechanisms that shape the aggregates.

[21] Since the new steady state is reached after around 40 years, the average growth rates of output and capital stock are 0.7% and 0.2%, respectively.

Table 2.9: Entrepreneurial statistics under the TCJA

		Key provisions of the TCJA			
Averages	Benchmark	**All**	**bus deduction**	**corp cut**	**top cut**
% of entrepreneurs	7.10	7.24	7.37	7.03	6.93
entry rate(%)	2.61	2.65	2.70	2.60	2.55
exit rate(%)	20.9	20.6	20.5	20.9	20.9
tenure in entrepreneurship(yrs)	8.69	8.88	8.88	8.66	8.66
% of constrained E	25.36	25.19	25.45	25.52	24.98
asset	10.76	11.88	11.47	10.75	11.30
capital size	13.70	14.89	14.61	13.54	14.27
optimal capital size	14.86	15.91	16.00	14.61	15..58
profitability (%)	18.24	16.91	17.34	18.17	17.75
tax-to-profit ratio(%)	33.66	25.94	26.16	34.27	32.86
% of leveraged Es	93.55	92.70	93.42	93.03	93.13

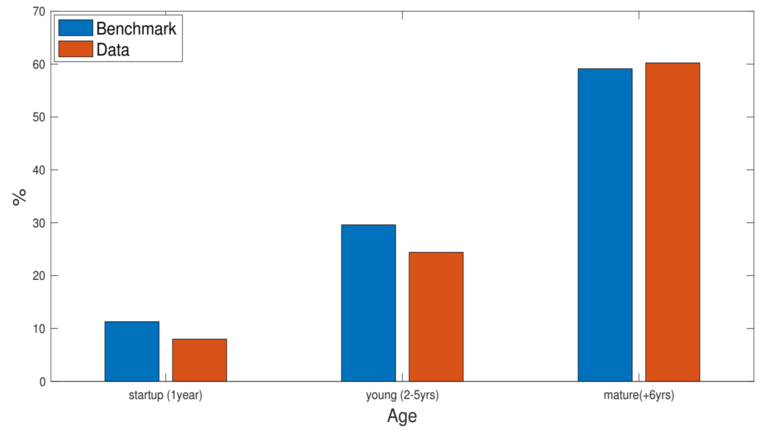
Note: Optimal capital is capital invested when firm is unconstrained. Profitability is defined as the ratio of the operating profit to the amount of invested capital. Tax-to-profit is tax paid by a firm out of its profit. Leveraged entrepreneurs is the fraction of firms borrowing from the banking system and the constrained firms are defined as those hitting their borrowing constraint.

The corporate tax cut provision has almost zero effect on output as indicated in tablechap2:tab7 (0.04%) . In fact, one can readily notice in the fifth column of table 2.9 that, the exit rate from entrepreneurship increases by 0.3% while the entry rate goes down by 2.1%.[22] This fact generates a net drop of 1.4% in the population of entrepreneurs (negative extensive margin). The remaining pool of entrepreneurs is more constrained and less profitable, operates relatively smaller firms(negative intensive margin), pays higher tax liability and relies less on external financing than the benchmark's one. These two negative effects then mitigate the positive one due to the increase in risk-free asset for workers and retirees. Eventually, entrepreneurial capital and output shrink. And despite the rise of investment in corporate sector, aggregate output is almost not affected (0.04% increase). As one cuts only top tax rate, the argument goes, but the intensive margin is larger to counterbalance the negative effect on savings. Therefore, the aggregates in this scenario rise. The biggest effect stems from the deduction case (third column) where entrepreneurial population and entry rate increase by 3% while exit rate is reduced by 2%. On average, firm size is larger compared to that in the corporate and top tax cut's scenarios. Thus the extensive margin amplifies the intensive one by allowing small businesses to participate to the overall capital formation. It is this mechanism that in some

[22]These numbers are obtained by computing the percentage change between the exit and entry rates from the *corp cut* column and that of the benchmark.

extent, transcends when the TCJA's complete package is implemented.[23]

Figure 2.1: Age distribution of firms



Note: Startup is a 1-year firm and young firm, a firm between 2-5 years. Mature or old firm's category regroups all firms more than 5 years. Data from Business Dynamic Statistics (BDS, 2014)

Figure 2.1 gives an overview of the firm age distribution in the model compared to the data. The model fairly replicates the upward sloping pattern of the data with respect to the metric I use to categorize firms' age. Old firms are dominant since they represent more than 60% of all firms in the economy. This trend is consistent with the facts in Pugsley and Sahin (2015) who document the startup deficit in the US economy over the last 30 years.

Figures in table 2.10 summarizes how each category of firms fares under the TCJA and its different provisions. An overall look shows that the above-mentioned pattern is found in all scenarios. Moreover, startups face stringent borrowing constraint than the others, but paid less taxes to operate. The TCJA reduces startups and young firms' share by 7% and 2%, respectively. Instead, old firms' share rises by 2%. Intuitively, when tax burdens are alleviated, firms are able to thrive and stay a bit longer than before, this channel reduces the share of startups (dominant effect of the deduction scenario). As firms grow, some old firms take advantage of the top tax cut and exit, inducing a

[23]The second layer of forces shaping the results of the different experiments is the extensive and intensive margins in the business sector. Annex 4.7.1 shows that in the 20%-deduction case, the participation and the investment margin are both positive, namely more entrepreneurs in the business sector who invest more in average. In the top tax cut scenario however, while there is more investment on average relative to the baseline, the fraction of entrepreneurs falls. This is due to the top-tax-cut feature of this provision, and the fact that not everyone is in the top earners' group to take advantage of the cut.

drop in their share in the firms' ecosystem and an enlargement of young firms' pool (coupled effect of corporate tax and top tax cuts). Nevertheless, the strong incentives given to entrepreneurial businesses overturns the previous decline and make older firms predominant in the long run.

Table 2.10: Entrepreneurial statistics by firm age under the TCJA

		TCJA			
Averages	Benchmark	All	bus deduction	corp cut	top cut
startup (1 year)					
% of firms	10.53	9.78	9.77	10.61	10.79
asset	3.92	4.41	4.49	3.98	3.96
capital	3.81	3.75	3.69	3.7	3.80
optimal capital	11.10	10.48	10.69	11.01	11.22
profitability(%)	12.00	11.30	11.59	12.10	11.96
tax-to-profit ratio	5.50	4.08	2.37	6.84	6.67
% of leveraged Es	86.45	84.16	85.02	85.14	86.50
% of constrained firms	22.71	23.05	26.72	21.71	24.14
young firm (2-5 years)					
% of firms	22.88	22.48	22.42	23.04	22.90
asset	15.31	15.33	15.10	14.93	15.43
capital	15.92	15.65	15.63	15.34	15.91
optimal capital	27.29	28.00	27.64	26.30	29.11
profitability(%)	16.19	15.60	15.76	16.09	16.13
tax-to-profit ratio	17.30	12.95	11.49	18.00	18.14
% of leveraged Es	93.85	93.64	94.18	95.46	93.64
% of constrained firms	10.18	10.92	11.82	10.35	11.46
mature firm (>5 yrs)					
% of firms	66.59	67.73	67.81	66.35	66.33
asset	134.61	150.07	144.57	134.65	141.70
capital	172.74	189.53	185.71	171.04	180.24
optimal capital	742.65	847.20	830.66	725.49	788.10
profitability(%)	23.40	21.90	22.32	23.25	23.02
tax-to-profit ratio	34.04	26.21	26.47	34.66	33.20
% of leveraged Es	95.81	94.98	95.57	95.40	95.40
% of constrained firms	1.27	1.22	1.17	1.12	1. 36

Note: Optimal capital is capital invested when firm is unconstrained. Profitability is defined as the ratio of the operating profit to the amount of invested capital. Tax-to-profit is tax paid by a firm out of its profit. Leveraged entrepreneurs are the fraction of firms borrowing from the banking system and the constrained firms are defined as those hitting their borrowing constraint.

2.5.3 Distributional effects

Economic inequality is higher under the TCJA. Although the economy enjoys higher output, investment and consumption in the long term, income and wealth Gini increases by 0.02% and 1.3%, respectively. To the extent that, a revenue-neutral condition should be satisfied each period, the average effective tax rate increases and hits poor-income individuals. Thus, the initial cuts tend to fade as time goes by. Table 2.11 shows that this trend is also present in each occupational group. Income inequality is relatively stable across tax provisions for workers, but that of entrepreneurs increases the most. Indeed, the reduction by 20% of the taxable income for entrepreneurs allows them to allocate more resources toward savings and investment. Accordingly and given that entrepreneurs also have large heterogeneity among them, this windfall of income generates different patterns of wealth accumulation exacerbating the initial inequality.

The corporate tax cut provision has surprisingly negative effects on inequality. The hike in the after-corporate tax interest rate boosts savings made by poor-income individuals. This induces higher wealth accumulation subsequently and, therefore reduces the gap between wealthier and poorer. As far as top tax cut is concerned, the raise in wage and the drop in after-tax interest rate allow poor-income individuals to catch up with top earners since they rely heavily on labor income, which translates to a reduction of the income Gini within workers. In the same time, the reduction in interest rate reduces these agents' incentive to save increasing therefore the wealth gap. Thus, wealth Gini rises up with respect to the *status quo*.

Table 2.11: TCJA and economic inequality (Gini index)

		TCJA			
Variables	Benchmark	All	bus deduction	corp cut	top cut
Wealth	0.822	0.833	0.829	0.798	0.828
Income (Workers)	0.518	0.518	0.518	0.519	0.518
Income (Entrepreneurs)	0.537	0.547	0.546	0.536	0.541
Income (+ retirees)	0.554	0.555	0.556	0.552	0.554

Considering dispersion in consumption, disposable income and asset, one sees readily from table 2.12 that the reform generates large heterogeneity within and between occupations. While variance in consumption on average is higher in the reformed economy, that of the disposable income and asset are lower almost for all workers (namely, those outside the top 10th decile). In fact, the drop in the dispersion of the disposable income and savings is related to the reduction feature of tax burden in the TCJA complemented with the overall progressivity of the tax code. However, the large increase in income and asset dispersion for the top decile workers (dominant effect of the top tax cut) drives up higher variability in consumption for all workers. Therefore with more disposable income, inequality in consumption rises. On the other hand, entrepreneurs as a group see an increase in the three dispersion measures. I then argue that the 20%-deduction exhacerbates the initial inequality already presents amongst entrepreneurs. Since the business deduction's provision drives typically the TCJA's effect, top entrepreneurs take more advantage of the new incentives than the remaining business owners. Having to paid low tax liabilities, they hold higher income, save and consume more which amplifies the within inequality: wealthier entrepreneurs are getting simply wealthier. As a general result, the TCJA induces higher variability in the economy.

Table 2.12: Inequality by occupation and income group

Pre-tax income deciles	Var(log consumption)		Var(log disposable inc.)		Var(log asset)	
Workers	Bench.	% Chg	Bench.	% Chg	Bench.	% Chg
< 50	0.049	**1.48**	0.040	**0.15**	1.037	**-0.08**
50-60	0.029	**12.19**	0.006	**-12.28**	1.819	**-7.07**
60-70	0.030	**2.73**	0.005	**10.38**	2.075	**0.21**
70-80	0.050	**2.89**	0.011	**-3.39**	2.342	**0.75**
80-90	0.081	**6.93**	0.011	**-4.31**	2.560	**0.88**
91-99	0.106	**7.27**	0.053	**12.54**	1.624	**5.92**
99-100	0.156	**3.16**	0.060	**1.48**	4.356	**2.32**
All workers	0.284	**2.28**	0.413	**-0.48**	2.008	**-0.49**
Entrepreneurs						
< 50	0.108	**3.24**	0.025	**28.27**	0.619	**-2.01**
50-60	0.102	**5.61**	0.005	**6.10**	0.507	**0.99**
60-70	0.117	**22.04**	0.005	**18.77**	0.604	**14.68**
70-80	0.154	**3.70**	0.010	**0.32**	0.716	**2.06**
80-90	0.158	**14.29**	0.016	**13.13**	0.683	**8.81**
91-99	0.224	**9.59**	0.117	**14.41**	0.655	**4.21**
99-100	0.176	**4.23**	0.106	**7.03**	0.313	**0.82**
All entrepreneurs	0.434	**11.56**	0.727	**13.86**	1.298	**5.90**
All (+retirees)	0.379	**7.46**	0.466	**5.35**	2.426	**1.61**

The tax reform modifies the distribution of effective tax rate with higher tax burden on poor-income individuals. Indeed, the revenue-neutral condition wipes out the potential tax relief contained in the reform, typically for lower income groups. In table 2.13, although the upward sloping trend in the effective tax rate along the income distribution is consistent in all provisions as in the benchmark economy, the tax burden is shifted away from the top one earners' group and is then redirected toward lower groups by a clear reduction of transfers particularly for under-the-median group. For example, the bottom 10 receives 7.5% of its pre-tax income as transfers in the benchmark economy when the top one pays 38.32%. However, under the TCJA, the top one's effective tax rate decreases by 4.87 percentage point meanwhile that of the bottom 10 increases by 4.20 percentage point. Thus, the welfare implications are not immune to this trickle down tax burden shifting.

Table 2.13: Distribution of effective tax rate (%)

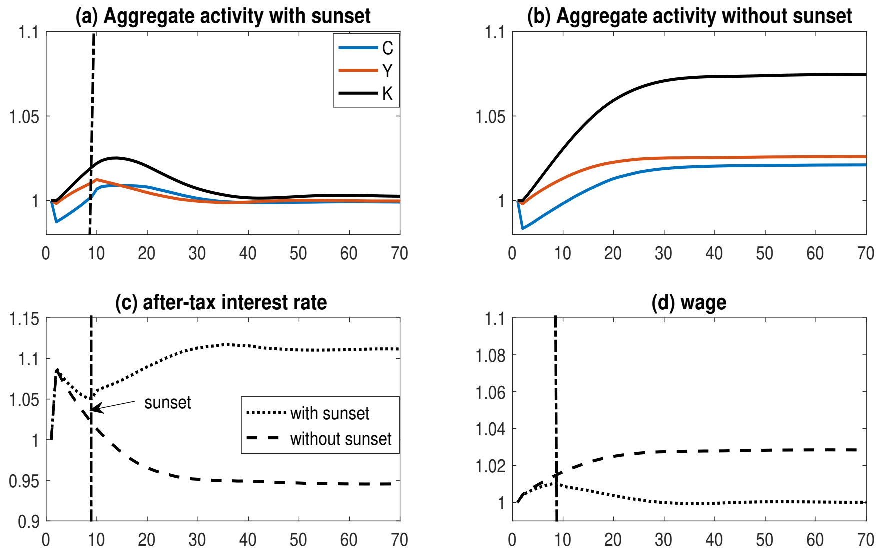
	Pre-tax income percentiles					
Economy	All	<0.10	0.10-0.50	0.50-0.90	0.90-0.99	1%
Benchmark	20.57	-7.50	-1.23	13.98	29.65	38.08
Bus. deduction	20.45	-5.08	0.95	15.14	28.25	35.25
Corp. tax cut	20.96	-6.84	-0.51	14.61	29.99	38.13
Top tax cut	20.56	-6.29	-0.14	14.88	29.37	35.84
TCJA	20.77	-3.30	2.67	16.58	28.16	33.21

Note: Effective tax rate is the ratio of total tax paid to pre-tax income.

2.6 On the transitional path of the TCJA

Thus far, I discussed the long-run effects of the TCJA and its key provisions. This section turns to understanding the dynamics of main aggregates along the transition path to the extent that, the transition helps uncover the real magnitude of the variables' responses. Such a second layer of analysis is even interesting given that not all provisions enacted in the TCJA are permanent. Indeed, the tax law requires the top marginal tax cut and the deduction for pass-throughs businesses to expire by December 2025, namely 8 years following the enactment. By contrast, the corporate tax cut is set up to be permanent, making the TCJA to turn simply to a corporate tax cut by the end of 2027. Accordingly, in computing the transition path, I also introduce this requirement to stay as close as possible to the tax law.

Figure 2.2: Evolution of aggregate quantities



Note: Years of transition are in the horizontal axis, while the relative value of each value to its pre-reform level is in the vertical axis. Sunset is the expiration date for individuals and pass-throughs' provisions (2025 in the TCJA). Interest rate is the after-corporate tax interest rate i.e. $r_{after} = (1 - \tau_{corp})r_{before}$.

2.6.1 *Aggregate activity*

Figure 2.2 allows one to extend the analysis of the TCJA by accounting for transitional dynamics of the different variables. In the first period, given that the labor efficiency decreases in the corporate sector, the capital-labor ratio rises up leading to a low before-tax rate and more wage. But provided the exogenous reduction of the corporate tax, the after-tax rate increases almost by 9%, instead (panel (c)). The return on risk-free assets becomes attractive, which creates a 1% decrease in aggregate consumption. Thereon, it will take a decade for the consumption to recover its pre-reform level (panel (a)). Yet, after two more decades, consumption returns to a slightly lower level than the baseline. As indicated in panel (a), the aggregate capital does not jump instantly to its final level because it is predetermined in the first period, but increases steadily up to the first decade and implies a growth rate of 0.23%. From the first decade to the third one, this dynamics is reversed to generate negative growth rate. Aggregate capital also stays close to its pre-reform level in the long run. The slight drop in wage (panel (d)) following the second decade is not enough to counterbalance the negative effect of higher capital cost(panel (a)) on the aggregate investment in the long run. Aggregate output has a similar dynamics with a lower magnitude and its has a growth rate of 0.12% over the first decade.

Panels (b) to (d) also depict the transition path of the aggregate variables with the assumption of no expiration in any provision. This gives a way of gauging the importance of the eliminated provisions. The expiration year is indicated in all panels (expect panel (b)) by a vertical dash line (year = 9). One can see readily from panel (c) that once the sunset kicks in, the after-tax interest rate starts rising while the decreasing pattern remains if there is no expiration. As argued in the steady-state analysis (section 2.5), the 20% deduction for entrepreneurs is the main driver of the TCJA's effects. Therefore, the sunset of this provision reverses the positive effects of the TCJA on the aggregate activity (panel (a) vs. panel(b)) and also the entrepreneurial activity discussed below.

2.6.2 *Comparison with others estimates*

To the extent that the TCJA is a new and a major tax overhaul of the tax system both for individuals and businesses, many U.S. federal agencies have released their estimates of the potential effects of the tax law.

Table 2.14: Comparison of growth rates

	10-year window					With sunset		Without sunset	
Variables	JCT	CBO	PWBM	Model(yr-neutral)	Model(10yr-neutral)	Decade	Long run	Decade	Long run
Output	**0.70%**	**0.70%**	**0.06 to 0.12 pp**	0.70%	0.90%	0.12%	0.00%	0.14%	0.04%
Capital	**0.90%**	n.a	n.a	1.71%	2.12%	0.23%	0.004%	0.34%	0.11%
Consumption	**0.70%**	n.a	n.a	-0.82%	0.90%	0.08%	-0.001%	0.002%	0.03%
Deficit/GDP (not growth rate)	**-0.61%**	**-0.61%**	**-0.83%**	-	**-1.70%**	-	-	-	-

Note: Sunset period is the time period for which individuals and pass-throughs' provisions are scheduled to expired. In the TCJA , this time period is 2018-2025. Yr-neutral requires revenue neutrality each period while 10yr-neutral implies that government budget balances over the 10 year-budget window as is the case for Congressional Budget Office (CBO), Joint Committee on Taxation (JCT) 'estimations. Growth rate is the average growth rate over the 10-year budget window or over the transition time for the long run. PWBM: Penn Wharton Budget Model, n.a=not available, pp=percentage point.

I report in table 2.14 the estimates by the Joint Committee on Taxation (JCT, 2017), the CBO (2018), the PWBM (2018) and that of the current model.[24] The Joint Committee

[24] For instance, the Joint Committee on Taxation uses for its conventional estimations three macroeconomic simulation models to simulate the growth effects of the bill: (1) the Joint Committee staff's Macroeconomic Equilibrium Growth("MEG") model; (2) an overlapping generations model ("OLG"); and (3) the

on Taxation predicts average growth rates of 0.7%, 0.9% and 0.7% for output, capital stock and consumption, respectively, over a ten-year budget window. The corresponding figures in the present simulation are 0.70%, 1.71%, and -0.82% for output, capital stock and consumption growth rate, respectively. The forecasts are quite close, except for consumption. The revenue-neutral condition requires individuals to save more in order to pay for the tax cuts, therefore reducing their consumption as shown in panel (a) of figure 2.2. Otherwise, if neutrality is only required over the 10-year budget window as in the JCT (2017) ′ estimates, consumption growth is positive. Overall my estimates from the above occupational choice model is in the range of the U.S. federal agencies' figures.[25]

The table also adds the growth rate before both the top marginal tax cut and business income deduction provisions expire (Column *"With sunset"*). Figures in the long run are lower than that of the decade. In fact, there is a lag is the adjustment of capital stock making the positive incentives contained in the two previous provisions to have a hysteresis effect. That is, their effect persists somehow even after their expiration. Nevertheless, the long-run cannot sustain costly capital due to the hike in the interest rate, thereby induces a lower growth rate in the aggregate activity.

The last four columns in table 2.14 allows one to contrast the effect of the expiration of the two provisions. For example, over the first decade, the continuing positive effect of these provisions will generate 0.02 (0.14%-0.12%) and 0.11(0.34%-0.23%) percentage point increase in output and capital stock relatively to the sunset scenario, respectively. On the other hand, consumption growth rate is much lower with extended provisions since it takes more than a decade for the economy to reach its new steady state with higher aggregates. In the long-run though, there is a net advantage of extending all provisions since all aggregates experience positive growth rates.

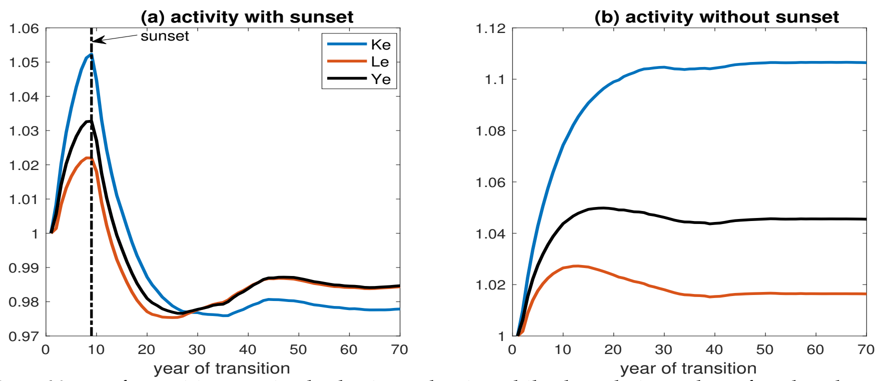
In the last line, the budgetary effects of TCJA are outlined. The figures forecast the

Joint Committee staff's dynamic stochastic general equilibrium model ("DSGE"). These models altogether capture many aspects of the tax law even though each of them uses some simplifying assumptions in order to deal with certain features of the bill. For instance, the underlying structure of the MEG model relies more on reduced form behavioral response equations, while the OLG and DSGE models incorporate more theoretical microeconomic foundations. Also in the MEG and DSGE models, monetary policy conducted by the Federal Reserve Board is explicitly modeled which is absent in the OLG model. See JCT (2018) for more details on the modeling assumptions.

[25]Focusing specifically on the user cost mechanism, Barro and Furman (2018) find that the TCJA (with expiring provisions) will increase the level of output after 10 years by 0.4% and induce an annual growth rate of 0.04 percentage point relative to the baseline. Otherwise, when provisions are made permanent, output level increases by 1.2% while the change in annual growth rate is 0.13 percentage point.

average revenue loss as a fraction of GDP following the implementation of the new tax bill over the 10-year budget window. The different estimates of the federal agencies are close and amount between $1.45 trillions and $1.197 trillions at the end of 2027. In the model where I allow revenue neutrality over the budget window(10-yr neutral), the average deficit represents 1.70% of the GDP.[26]

Figure 2.3: Evolution of entrepreneurial variables I



Note: Years of transition are in the horizontal axis, while the relative value of each value to its pre-reform level is in the vertical axis. Sunset is the expiration date for individuals and pass-throughs' provision (2025 in the TCJA).

2.6.3 Activity in the entrepreneurial sector

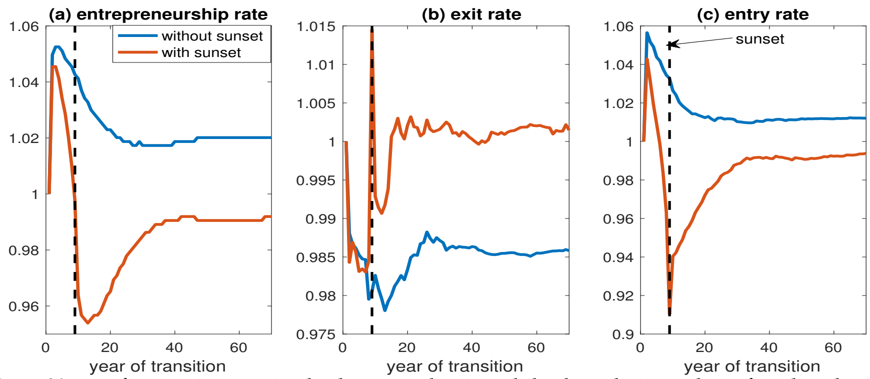
The aggregate activity inherits the dynamics in the entrepreneurial sector and this is emphasized in figure 2.3. Panel (a) shows how output, labor demand and investment fare when the TCJA is implemented with expiration of some provisions. The broad tax incentives for entrepreneurs induces a positive growth rate up to 5%, 3% and 2% in investment, output and labor, respectively. Once the two provisions expire by the end of the 8th year of transition (2025), all variables reverse their course as seen in the aggregate case (figure 2.2). Higher interest rate makes capital costly and the entrepreneurial sector even riskier for a would-be entrepreneur. Therefore, the fall lasts almost the second decade and the entrepreneurial activity stays under its baseline level. A comparison with panel (b) readily demonstrates the effects of the suppressed provisions in sustaining the capital formation. For instance, entrepreneurial investment will grow by 10%, instead.

[26]To calculate the deficit in this scenario (10-yr neutral), I compute the difference between the revenue collected each of the 10 years and its baseline value. I then divide these figures by their corresponding GDP. The final result is just an average over the budget window.

The entry and exit process in the non-corporate sector also gives one more layer to understanding the shape of the entrepreneurial activity. The positive incentive contained in the TCJA alleviates the burden on entrepreneurs which turns out to render the entrepreneurial sector less riskier than before. Accordingly, the fraction of entrepreneurs increases in the first period of transition (panel (a) of figure 2.4) resulting from the drop in exit rate (panel (b)) and a hike in the entry rate (panel (c)). This situation holds regardless the extension or not of some provisions. However, the fact that borrowed capital becomes costly due to the raise in the after-tax interest rate, the exit rate starts to rise while entry rate falls. The net effect of those two dynamics generates a lowering of the entrepreneurs' population, which is more pronounced in the sunset case, namely around the 10th year of transition. Thereafter, entrepreneurship rate increases over the next two decades, but remains under its pre-reform level. Indeed, over time and due to the increase of the interest rate, the marginal worker accumulates more wealth and overcomes the borrowing constraint at the entrance of entrepreneurship. But subsequently, the expiration of the two provisions triggers the positive incentive of the tax cut to vanish increasingly, which reinstates the risky feature of the entrepreneurial sector. Even with the combination of a raise in entry rate and a fall in the exit rate, the business sector shrinks relative to the baseline.

When all provisions are made permanent, exit increases while entry goes down since the business cost is now higher, mainly due to the 3% hike in wage (panel(d) in figure 2.2). Then, a would-be entrepreneur in the margin is likely to choose the paid-work sector that is less riskier and more attractive. Nonetheless, as the panel (a) of figure 2.4 displays, the extension of the provisions sustains higher share of entrepreneurs in the population as compared to the non-permanent scenario. On average, entrepreneurship and entry rates grow at 2% relatively to their pre-reform levels.

Figure 2.4: Evolution of entrepreneurial variables II



Note: Years of transition are in the horizontal axis, while the relative value of each value to its pre-reform level is in the vertical axis. Sunset is the expiration date for individuals and pass-throughs' provision (2025 in the TCJA).

2.6.4 *Welfare analysis*

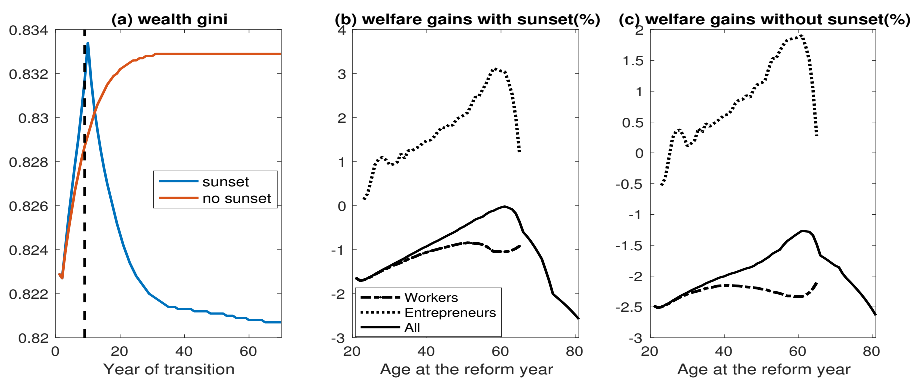
Table 2.15: Welfare gain by occupation (%)

Workers	CEV	support	**Entrepreneurs**	CEV	support	**All (+ retirees)**	CEV	support
Bus. deduction	-1.44	0.15	Bus. deduction	1.29	69.60	Bus. deduction	-1.28	5.54
Corp. tax cut	-0.10	23.80	Corp. tax cut	0.36	77.92	Corp. tax cut	0.02	37.32
Top tax cut	-0.69	3.16	Top tax cut	-0.18	27.64	Top tax cut	-0.60	5.32
TCJA	**-2.27**	**1.00**	**TCJA**	**1.31**	**63.77**	**TCJA**	**-1.95**	**5.82**

In all provisions of the TCJA (table 2.15), workers suffer welfare losses when, only the top tax cut generates a loss for entrepreneurs. These losses are pronounced in the business deduction and the top tax cut scenarios. In fact, as shown in table 2.13, the bottom 10 percentile sees its transfers reduced from 7.5% to 5.1% and 6.3% in the business deduction and top cut cases, respectively. They have to pay for the average tax cut in the whole economy. The surprising result of the corporate tax cut on reducing the inequality can be emphasized here. Even though, workers' group suffer a loss, the overall economy experiences 0.02% consumption gain, thanks to higher returns on risk-free assets. Recall from table 2.8 that when this provision alone is implemented, the after-tax interest rate rises up by 11%, then retirees who partially live off their assets benefit from this windfall income. Furthermore, since they are likely to be in lower income group, they also take advantage of transfers (albeit, reduced) paid out to the bottom 10 percentile of the income distribution. This provision is the only one where the tax cut is also paid for by the top 1% earners' group. With the raise in after-tax interest rate, they are incentivized to increase their savings, but given they also have higher wealth share they end up contributing more as a group.

Taking into account the mitigating dynamics of the different provisions of the TCJA, the whole population suffers a 1.95% loss in the reform year. Without surprise, the business-oriented feature of the TCJA makes entrepreneurs stand by it whereas workers and the general population find it difficult to support.

Figure 2.5: Inequality and welfare gain



Note: The vertical axis represents the consumption equivalent variation, except for wealth Gini. Sunset is the expiration date for individuals and pass-throughs' provision (2025 in the TCJA).

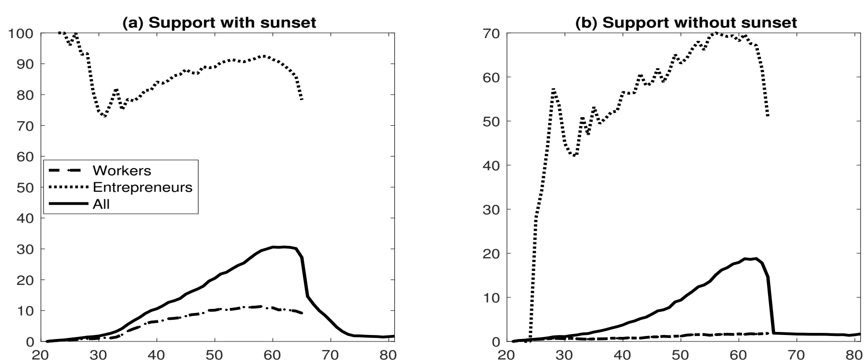
The tax cuts have also an impact of the underlying inequality in the economy. Figure 2.5 then gives a grasp of some dimensions. For instance, in panel (a), one sees readily the increase of the wealth Gini following the cuts. In fact, the alleviation of the tax burden across the income spectrum allows individuals to accumulate more savings, but since the TJCA has a flavor of top and business-oriented tax cut; typically, only those entrepreneurs at the top really take advantage of the new provisions making them save more than the rest of the population. Thus, wealth Gini goes up. However, the elimination of the top tax cut and business deduction reduces the force of this channel which ends up lowering the wealth gap in the population toward its baseline level. This is the same result when only corporate tax cut is implemented in section 2.5.3. On the other hand, the permanence of all provisions sustains the previous accumulation force, namely top entrepreneurs being able to keep up their savings. Therefore, the wealth Gini continues to rise up to almost 1.25% relative to its pre-reform level.

While table 2.15 shows the welfare gains by occupation, panels (*b*) and (*c*) in figure 2.5

allow an age profile analysis by occupation for the population alive at the time of reform. Panel (*b*) depicts the welfare gains age profile when deduction for pass-throughs and top earners are set to expire. Regardless of the occupation there is an hump-shaped age profile for the welfare gains in the current population. This mimics the standard asset profile over the life cycle. Indeed, since the TCJA is a cut for wealthy individuals, they take advantage of the tax relief and save even more. Young agents start their life with no wealth and must build it up over the course of their life, thereby making them hurt the most by the reform. With no surprise, entrepreneurs are better off over the life cycle as compared to workers. This is mainly due to the 20-percent-deduction provision allowing them to boost their saving and consumption. For permanent provisions as in panel (*c*), the result is qualitatively similar. Entrepreneurs are still well off over the life cycle, but to a lesser extent since they face higher labor cost in the business sector (namely 3% wage increase, panel (*d*) Fig. 2.2). Workers and retirees see their losses deepened given that they now pay higher taxes and receive less transfers on average. Accordingly, extending the provisions of the TCJA is welfare reducing.

There is a strong support for the reform by entrepreneurs given that they experience higher welfare gain in the outset of the tax cuts (figure 2.6). As in figure 2.5, the support displays a hump-shaped profile, with higher support by entrepreneurs of all age cohorts. The TCJA without expiration has almost no support from workers and retirees since they are the ones who ultimately will pay for these tax breaks for businesses.

Figure 2.6: Support for the reform



Note: The vertical axis represents the fraction in percentage of individuals with positive consumption equivalent variation. The horizontal axis defines the age of each cohort at the reform year. Sunset is the expiration date for individuals and pass-throughs' provision (2025 in the TCJA).

2.7 Conclusion

Who gains or loses from a tax reform? How well the economy will perform? Those questions are reminiscent of any tax change. The proponents of the TCJA are very optimistic about the trickle down mechanism which lifts all boats as is emphasized in President Trump's remark.[27] The quantitative evaluation of key provisions of the TCJA under revenue neutrality in this paper show mitigated results. This reform spurs on average, a small output growth and capital formation over the next decade, meanwhile, wealth and income inequality increases since these tax rebates are mainly targeted to businesses relatively to individuals. The provision allowing business owners to reduce their taxable income by 20% emerges to be the most significant one, and therefore is the main driver of the TCJA's effects on the US economy. While entrepreneurs, namely those at the top 10 percentile enjoy higher lifetime consumption gain, the rest of the population is worse off with respect to the status quo. This situation then induces a lower support for such a business-oriented tax cut.

In evaluating the TCJA effect, this paper does not take in account the debt channel the government can use to partially finance the tax cuts. In fact, the debt is becoming a bigger concern for the US economy since the $ 1.5 trillions deficit from the TCJA will add up to $ 20 trillions of total deficit over the next ten years. Therefore, understanding the impact of the TCJA with this assumption is worth exploring. Otherwise, the differential taxation system reinforced in this new tax code could be seen as if it is a new loophole, and wealthier individuals may try to take advantage of this situation. A recent case has been documented by DeBacker et al. (2016) in the state of Kansas's pass-throughs tax-free experiment. Discussing the implications of the TCJA with potential tax avoidance opportunities is another line of investigation that I leave for future research.

[27]" This huge tax cut...will be rocket fuel for our economy. ...The biggest winners from this transformation will be everyday families, from all backgrounds, from all walks of life, and our great companies, which will produce the jobs. They are going to produce jobs like you've never seen before." Available at https://www.whitehouse.gov/briefings-statements/remarks-president-trump-tax-reform/

Chapter 3

Optimal Business Income Taxation

3.1 Introduction

Optimal taxation is concerned with minimizing the distortions to the economy when raising revenue or achieving redistributive objectives. In the context of income taxation, one way to advance towards that goal is to distinguish between taxpayers based on their source of income. I consider a distinction between business income, as it is generated by self-employed, entrepreneurial activity, and other forms of income. Entrepreneurs generally face a different economic environment than workers or large corporations. Their incomes are risky, reflect a mixture of labor and capital inputs and potentially higher on average relative to workers. They face stricter financing restrictions relative to large corporations. These differences affect economic behavior and outcomes, e.g. entrepreneurs have a higher saving rate and, therefore, a larger net worth. A benevolent tax planner would prefer to treat entrepreneurs separately. This paper provides a quantitative analysis of the optimal taxation of entrepreneurial income.

I conduct my analysis using a macroeconomic model, where entrepreneurial status is endogenous to the tax policy. The model builds on Cagetti and De Nardi (2006), modified to feature life-cycle dynamics, business experience and an income tax system. The life-cycle structure of the model is an important feature to consider in the current modeling because both entrepreneurs and workers' wealth and income, change throughout their lifespan. I introduce managerial skill accumulation which leads entrepreneurs to become more productive with experience.

Households in the model save for precautionary reasons, for retirement, and potentially to invest in their business in a financially constrained environment. The need to circumvent borrowing constraints leads to a high saving rate among would-be entrepreneurs and entrepreneurial households. Production is carried out by the entrepreneurs and a non-constrained corporate firm. Personal income is subject to non-linear taxation.

I calibrate the model to replicate the wealth and income distributions for workers and entrepreneurs, and the key characteristics of the entrepreneurial sector. Business experience is instrumental for delivering a good match of the fraction of entrepreneurs among the top earners and the share of wealth that they hold.

Next, I use the model to simulate economies with alternative tax reforms, where the tax treatment of business income is permanently altered. In particular, I allow a benevolent planner to set the tax rate on business income for entrepreneurs to maximize the average utilitarian welfare while keeping total tax revenue constant. I first consider a steady-state analysis and then follow with an analysis of the optimal tax reform when accounting for the entire transition path. This gauges the effect of the planner's discount factor on the well-being of future generations. Second, I investigate the effect of the planner's taste for redistribution on the optimal tax rate. Finally, I discuss how the consideration of cumulative business experience affects the optimal tax rate.

When the planner is concerned solely with long-run outcomes, I find the optimal tax rate of business income to be 25%. At the steady state equilibrium associated with this tax rate, average output is 0.2% higher than the benchmark economy, and average consumption decreases by 0.04%. The output gain is limited by a decline in the entrepreneurial sector in the long run. Indeed, at this tax rate, low and middle-income entrepreneurs can no longer bear the cost of running a business, and shut down. The higher cost also deters new entry. Therefore, the combined effect of the exit and entry margins more than offsets the increase in investment stemming from the wealthy entrepreneurs. On the other hand, the distribution of consumption becomes more dispersed.

When the planner considers the transitional dynamics, the optimal tax rate increases to 40%. Because capital is supplied inelastically in the short run and because some entrepreneurs hold large amounts of wealth, the planner has an incentive to increase average welfare by redistributing resources away from these wealthy entrepreneurs towards low and middle income groups. Average investment and output fall by more than 5% in the long run, but this is not enough to offset the short term gains from redistribution. The tax rate of 40% increases the cost of running a business, which discourages individuals from engaging in entrepreneurship. As a result, the business sector shrinks by 40% and entrepreneurial investment drops by 27%. Since business owners hold a large share of capital, their exit from entrepreneurship lowers the aggregate capital accumulation and induces an increase in the interest rate and a fall in wage.

The *ex-post* inequality captured by the consumption Gini is reduced given that the utilitarian planner has a strong motive for curbing inequality. However, this translates into mixed effects on welfare. While, on average, the population gains from this reform, business owners experience a large welfare loss. In fact, older workers (age 50 and plus) and the elderly in the first period of the transition, support such a reform because they have had time to accumulate wealth and then receive a windfall income from the increase in interest rate. The drop in wage induces a lower consumption for young workers who rely heavily on labor income.

When I modify the social welfare function, the optimal tax rate changes. First, if the utilitarian planner only considers the welfare of the generations alive at the reform year, the optimal tax is 50%. This represents a 10 percentage point increase with respect to the case with higher weight: the optimal tax decreases with the planner's discount factor. Intuitively, higher redistribution crowds out investment to the extent that the planner confiscates a large part of business owners' capital. Second, I characterize the optimal tax rate when the planner has no aversion for inequality, but cares about the insurance value of taxation. I refer to this scenario as (pure) efficiency. The optimal tax rate drops to 15%. In fact, risk and financial constraints are prevalent in the entrepreneurial sector, which prevent entrepreneurs to expand their investment. Thus the planner by reducing the optimal tax rate, incentivizes individuals to engage in productive entrepreneurship with more insurance. This gives rise to higher production in the economy.

Finally, the optimal tax rate is higher if accumulation of business experience and its impact on productivity are ignored. A lower tax rate not only encourages entrepreneurial activity but also lengthens the average duration of a business. This enables entrepreneurs to accumulate more business experience, and raises aggregate productivity. As a result, higher taxes become more distortionary to long-run output when business experience is considered, suggesting lower optimal tax rates.

The contributions of this paper are twofold. First, the paper analyzes optimal taxation of entrepreneurial income in a quantitative model accounting for transition. Specifically, I take full account of the welfare distribution along the transition to the new steady state following a *once-and-for-all change* in the tax system. I show that from a utilitarian perspective, it is desirable to separately tax entrepreneurial income at tax rate of 40%. But, the average welfare gain is small. If the ultimate goal is to foster production, then the optimal tax rate is 15%. Second, I show that endogenous business experience is an important feature to consider when setting tax rates for entrepreneurial income. The cumulative experience affects the return from entrepreneurship.

The quantitative literature has extensively discussed the optimal taxation of personal income[1] (Conesa and Krueger, 2006; Conesa, Kitao, and Krueger, 2009; Badel and Huggett, 2014; Kindermann and Krueger, 2014). These papers focus on worker households and abstract from entrepreneurial activity. Brueggemann (2016), considers a model with entrepreneurs to estimate the optimal top marginal income tax rate, but does not distinguish entrepreneurial income from other sources. A related set of papers provide a positive analysis of switching from progressive income taxation to linear taxation (Meh, 2005; Kitao, 2008; Bohácek and Zubrický, 2012). My paper differs from these because it is concerned explicitly with entrepreneurs, and it provides an analysis of *optimal* taxes.[2]

This paper shares common methodological elements with papers using alternative environments to solve for optimal tax rate with the transitional dynamics (Benabou, 2002; Domeij and Heathcote, 2004; Fehr and Kindermann, 2015; Bakış, Kaymak, and Poschke, 2015; Heathcote, Storesletten, and Violante, 2017). As a general result, the optimal tax rate increases with the planner's aversion to inequality and decreases with its relative valuation of future generations.

The reminder of the paper is structured as follows. Section 3.2 gives the model and its recursive formulation. Section 3.3 discusses model calibration. The evaluation of aggregate and distributional effects of optimal reform under a utilitarian planner is carried out in section 3.4.1 while section 3.4.2 extends the analysis to a variety of social welfare functions and discusses the key trade-offs. Section 3.5 provides a discussion of the results and section 3.6 concludes.

[1]For earlier discussion on optimal taxation of capital income in complete markets see (Chamley, 1986; Judd, 1985), and Aiyagari (1995) in incomplete markets. Panousi (2012), and Panousi and Reis (2012) show theoretically that in presence of uninsurable idiosyncratic investment or capital-income risk, the sign of the optimal tax is ambiguous. In a recent contribution, Guvenen, Kambourov, Kuruscu, Ocampo, and Chen (2017) find wealth tax superior to capital taxes in presence of heterogeneous returns among individuals over their life cycle. One can consider their capital income tax as a tax on entrepreneurial income. However, their purpose is no to do an optimal tax analysis with transition but rather to solve for an equilibrium that holds throughout the transition and in the new steady state while minimally deviating from the optimal tax rates found in the steady state.

[2]Using a Mirleesian framework, Scheuer (2014) shows theoretically that it is optimal to tax labor income and business income with separate non-linear tax schedules. His findings are derived from a static environment with private information. On the other hand, I also consider separate taxation, but business income faces linear taxation in a dynamic setup with overlapping generations.

3.2 Economic Environment

I build on Cagetti and De Nardi (2006) to allow individuals to choose occupation between paid-work and entrepreneurship. However, the simple life-cycle structure in their model does not enable one to fully describe the transition in and out of entrepreneurship. Therefore I adopt a life-cycle approach with lifetime uncertainty but without bequests. They work for the first R years followed by an inactive period of retirement. Individuals live J periods and start their life with zero initial wealth.

3.2.1 Demographics and preferences

The economy is inhabited by multiple cohorts of individuals of different ages. Each cohort is comprised of a continuum of measure one of individuals who live for a finite number of periods. Each period, an agent of age j decides whether to be an entrepreneur or a worker. Agent of age j maximizes the expected flow of utility given by

$$\mathbb{E}_0\left[\sum_{j=1}^{J}\beta^{j-1}u(c_j)\right] \tag{3.1}$$

where $u(c_j) = \frac{1}{1-\sigma}c_j^{1-\sigma}$ where σ is the rate of relative risk aversion. Each agent discounts future at rate $\beta \in (0,1)$.

3.2.2 Technologies

Work productivity

Labor supply is inelastic. A worker earns a market wage w per efficiency unit of labor ϵ_j, where ϵ_j denotes an age-specific productivity, which captures the average wage between workers of different age, and evolves deterministically along the life-cycle. Workers are also subject to idiosyncratic shocks, η, that are distributed according to the following stochastic AR(1) process.

$$\ln\eta_t = \rho\ln\eta_{t-1} + \epsilon_{\eta,t} \text{ where } \qquad \epsilon_{\eta,t} \sim N(0,\sigma_\eta^2)$$

Cumulative business experience and entrepreneurial production

The more time an agent spends in the business sector, the more productive he becomes as an entrepreneur experience rises, making the entrepreneur's human capital an essential input for the business to succeed. I define business experience at any age j by the total number of years an agent has worked as an entrepreneur in their career. Formally, let $o(a, z, , \eta, j, \kappa) \in \{worker, entrepreneur\}$ denote the occupational choice given asset, abilities, age j, and entrepreneurial experience κ, the accumulation of this experience is as follows

$$\kappa' = \kappa + \mathbb{1}_{\{o(a,z,\eta,j,\kappa)=e\}}, \tag{3.2}$$

where

$$\mathbb{1} = \begin{cases} 1 & \text{if } o(a, z, \eta, j, \kappa) = entrepreneur \\ 0 & \text{otherwise} \end{cases} \tag{3.3}$$

The production technology available in the entrepreneurial sector is in line with the span-of-control assumption (Lucas Jr, 1978). The entrepreneur rents working capital k at interest rate r and labor input l at market wage w in a constrained financial market environment. Markets arrangement are such that, the entrepreneur is able to borrow only up to a fraction $\lambda \geq 1$ of his initial wealth. Capital depreciates at rate δ. To capture the risky nature of entrepreneurial activity, I consider a stochastic entrepreneurial ability z following a Markovian process. The effective entrepreneurial ability is defined as $z_e = z\kappa^\theta$, where $\theta \in (0, 1)$ is the elasticity of the effective human capital with respect to experience. Therefore, the business income of the entrepreneur π is as follows

$$\pi(a, z, \kappa) = \max_{l \geq 0,\, k \leq \lambda a} z\kappa^\theta (k^\alpha l^{1-\alpha})^\gamma - \delta k - r(k - a) - wl \tag{3.4}$$

where $\alpha, \gamma, \in (0, 1)$.

Non-entrepreneurial sector:

Not all businesses in the economy are performed by individual entrepreneurs. There is also a group of relatively large and unconstrained firms which I refer to as corporations. I then suppose that these corporations are represented by a single corporate firm using a constant-returns-to-scale production function. To capture the effect of corporate taxation, the aggregate corporate firm pays a proportional corporate tax τ_c on its operating profit which is defined as production net of labor cost and capital depreciation.[3] The corporate firm then solves the following:

[3]Indeed, operating profit is expressed as $\tilde{\pi} = A_c K_c^\alpha L_c^{1-\alpha} - \delta K_c - wL_c$. One can then show that $\tau_c \tilde{\pi} = \tau_c \tilde{r} K_c$. Thus, the before-corporate tax is given by $\tilde{r} = r/(1 - \tau_c)$. Moreover, setting the interest rate in this way prevents pass-through entities to be subject to the corporate taxation (double taxation), which is consistent with the actual U.S. tax code.

$$\max_{K_c,L_c>0} A_c K_c^{\alpha} L_c^{1-\alpha} - (\tilde{r}+\delta)K_c - wL_c \tag{3.5}$$

with $\tilde{r} = r/(1-\tau_c)$

First order conditions give rise to

$$\tilde{r} + \delta = \alpha A_c \left(\frac{K_c}{L_c}\right)^{\alpha-1} \tag{3.6}$$

$$w = (1-\alpha)A_c \left(\frac{K_c}{L_c}\right)^{\alpha} \tag{3.7}$$

3.2.3 *Government and tax system*

Government levies proportional taxes on consumption(sales tax) $T_s = \tau_s C$, progressive taxes on personal income T_y and uses the proceeds to finance an exogenous outlay G and retirement benefits, B. I consider the below tax scheme on income.

$$y^d = \xi \min\{y_{top}, y\}^{1-\tau} + (1-\tau_{\max})\max\{0, y - y_{top}\} \tag{3.8}$$

$$t(y) = y - y^d \tag{3.9}$$

where y^d is agent's disposable income, y the total income and $t(y)$ the amount of tax collected. The first term in equation 3.8 captures the progressivity of the U.S. personal income tax which can be approximated by a log-linear function outside the top income bracket[4](Benabou (2002), Heathcote et al. (2014a), and Bakış et al. (2015)). The second term represents the tax liabilities of those individuals in the top end of income distribution with $\tau_{\max}$ the top marginal tax rate (Kaymak and Poschke (2016)). The income level y_{top} is the critical level equalizing the marginal tax rates. That is, $1 - \xi(1-\tau)y_{top}^{-\tau} = \tau_{\max}$. The tax system progressivity is captured by τ. Accordingly, if $0 < \tau < 1$ taxation is progressive, meaning an increase in marginal tax with respect to income. A regressive schedule, on the other hand, occurs when $\tau < 0$. The parameter ξ in equation 3.8 represents the average level of taxation in the economy and it also allows one to balance the government's budget at the equilibrium. Each period government's budget balances as

$$G + B = T_s + T_y + \tau_c \tilde{r} K_c \tag{3.10}$$

[4]This tax schedule rules out lump-sum transfers but allows agents to receive tax rebates or transfers as long as their total income $y \in (0, \xi^{\frac{1}{\tau}})$.

3.2.4 Recursive formulation

Households maximize the expected flow of utility given in 3.2.1. I assume no aggregate uncertainty and prices are constant in the steady state. Each period, an age-j individual starts with an initial wealth a, productivity η, entrepreneurial ability z, experience κ, and then chooses his current occupation. Workers earn income from labor, make consumption and savings decision. Entrepreneurs choose the working capital and labor input demand subject to the collateral constraint. Moreover, the entrepreneur gains one period of experience which will be essential in his subsequent ventures.

Agent's problem

a-Retiree's problem

After retirement, agents live off their savings and retirement benefits (b). Pension is paid out to any retiree regardless of his pre-retirement occupation. The problem of a retired agent for ages $j \in \{R, R+1, \ldots, J\}$ is given by

$$v_j(a) = \max_{a'} \left\{ u(c) + \beta v_{j+1}(a') \right\} \tag{Pr}$$

$$y_r = ra + b \tag{3.11}$$

$$(1+\tau_s)c + a' = y^d(y_r) + a \tag{3.12}$$

$$a \geq 0 \tag{3.13}$$

$$v_{J+1}(a) = 0 \tag{3.14}$$

Thus, during the retirement agent just chooses his next period asset holdings. To the extent that the agent's lifetime ends at J, equation 3.14 gives the one period ahead terminal utility which is zero. Recall that $y^d(.)$ is the net-of-tax schedule given in 3.8.

b-Working agent's problem

Before retirement, any agent in the economy has the following choice:

$$v_j(a,z,\eta,\kappa) = \max \left\{ v_j^w(a,z,\eta,\kappa), v_j^e(a,z,\eta,\kappa) \right\} \tag{3.15}$$

where $v_j^w(a,z,\eta,\kappa)$ and $v_j^e(a,z,\eta,\kappa)$ are the value functions of worker and entrepreneur, respectively.

b1-Worker's problem

Conditional on being on the labor market, an age-j worker solves the following recursive problem by choosing next savings and occupation.

$$v_j^w(a,z,\eta,\kappa) = \max_{a'} \left\{ u(c) + \beta \sum_{z',\eta'} \psi(z',\eta'|z,\eta) v_{j+1}(a',z',\eta',\kappa') \right\} \tag{Pw}$$

subject to

$$y_w = w\eta\epsilon_j + ra \tag{3.16}$$

$$(1+\tau_s)c + a' = y^d(y_w) + a \tag{3.17}$$

$$\kappa' = \kappa \tag{3.18}$$

$$a \geq 0, \quad j = 1,2,\dots,R-1 \tag{3.19}$$

The expectation is taken with respect to the underlying Markovian productivity distribution $\psi(z',\eta'|z,\eta)$ for the two abilities with the assumption that they are not correlated.[5] The worker's income stems from efficiency unit of labor per market wage. The budget constraint in (3.17) states that although the agent is bestowed with a given entrepreneurial productivity z, his current income does not depend on this productivity because he has chosen to be a paid-worker. Provided that a worker does not carry out production technology, he does not accumulate this specific entrepreneurial experience.[6] The equation 3.18 then shows the static accumulation of entrepreneurial skill.

b2-Entrepreneur's problem

The recursive problem of an entrepreneur is now stated as follows

$$v_j^e(a,z,\eta,\kappa) = \max_{a'} \left\{ u(c) + \beta \sum_{z',\eta'} \psi(z',\eta'|z,\eta) v_{j+1}(a',z',\eta',\kappa') \right\} \tag{Pe}$$

[5] This assumption is also made in Cagetti and De Nardi (2006). They compute a robustness check with correlated abilities but results are not affected.

[6] One could possibly think of a similar occupation-specific human capital accumulated in paid-work sector. This extension not only will increase the computation burden but also will not change the intuition carried over by the current setup. Indeed, one could take the relative of the two human capital and then normalize the paid-working one rendering models equivalent. On the other hand, one could also argue that, since the model explicitly keeps track of the labor efficiency unit, the human capital in the paid-work sector is somehow taken into account.

subject to (3.4)-(1.7), (3.19) and

$$y_e = \pi(a, z, \kappa) \tag{3.20}$$

$$(1 + \tau_s)c + a' = y^d(y_e) + a \tag{3.21}$$

$$\kappa' = \kappa + 1 \tag{3.22}$$

The main differences between the two occupations are the income earned in the current period and the accumulated human capital. In fact, the profit function $\pi(.)$ is a complex function which incorporates the borrowing constraints faced by the entrepreneur as described in section 3.2.2. The occupation-specific human capital gained in the business sector is defined in Eq (3.22) and translates the *learning-by-doing* process embedded in entrepreneurship. Hence, it is a latent variable behaviorally determined.

Equilibrium

At each point in time, individuals differ from one another with respect to age j and to state $s = (a, z, \eta, \kappa, o)$ i.e. asset holdings a, entrepreneurial productivity z, work productivity η, entrepreneurial experience κ and occupation $o \in \{W, E, Retiree\}$. Let $a \in \mathbb{A} = \mathbb{R}_+, z \in \mathbb{Z}, \eta \in \mathbb{H}, \kappa \in \mathbb{K}$ and $o \in \mathbb{O}$, and $\mathbb{S} = \mathbb{A}$ x $\mathbb{Z}$ x $\mathbb{H}$ x $\mathbb{K}$ x $\mathbb{O}$ the entire state space. Let $(\mathbb{S}, \mathcal{F}(\mathbb{S}), \phi j)$ be a space of probability, where $\mathcal{F}(\mathbb{S})$ is the Borel σ-algebra on $\mathbb{S}$: for each $\mathcal{B} \subset \mathcal{F}(\mathbb{S})$, $\phi_j(\mathcal{B})$ denotes the fraction of agents aged j that are in $\mathcal{B}$. Given the age j distribution ϕ_j, $Q_j(s, \mathcal{B})$ induces the age $j+1$ distribution ϕ_{j+1} as follows. The function $Q_j(s, \mathcal{B})$ determines the probability of an agent at age j and state s to transit to the set $\mathcal{B}$ at age $j+1$. The policy function for savings, consumption, entrepreneurial capital and entrepreneurial labor is given by $g_j^a(s), g_j^c(s), k_j(s)$ and $l_j(s)$, respectively.

Definition . Given a tax structure $\{\tau_s, \tau_c, \tau_I, \tau_{max}, \xi, b\}$, a stationary recursive competitive equilibrium is a set of **functions** $\{v_j^w, v_j^e, v_j, g_j^a, g_j^c, k_j, l_j(s)\}_{j=1}^J$, and **prices** $\{\tilde{r}, w\}$ such that

(i) given prices, the functions solve the household problem in (Pw), (Pe) and (3.15);

(ii) the prices satisfy the marginal productivity conditions i.e. $\tilde{r} = F_{K_c}(K_c, L_c) - \delta$ and $w = F_{L_c}(K_c, L_c)$;

(iii) capital and labor markets clear :

$$\sum_{j=1}^{R-1} \int_{\mathbb{S}} k_j(s) d\phi_j + K_c = \sum_{j=1}^{J} \int_{\mathbb{S}} g_j^a(s) d\phi_j$$

$$\sum_{j=1}^{R-1} \int_{\mathbb{S}} l_j(s) d\phi_j + L_c = \sum_{j=1}^{R-1} \int_{\mathbb{S}} \epsilon_j \eta d\phi_j$$

(iv) given the decision rules, $\phi_j(s)$ follows the law of motion:

$$\phi_{j+1}(\mathcal{B}) = \int_{\mathbb{S}} Q_j(s, \mathcal{B}) d\phi_j, \forall \mathcal{B} \subset \mathcal{F}(\mathbb{S});$$

(v) the government balances its budget:

$$G + B = \tau_c \left(\frac{r}{1 - \tau_c} \right) K_c + \tau_s \sum_{j=1}^{J} \int_{\mathbb{S}} g_j^c(s) d\phi_j + \sum_{j=1}^{J} \int_{\mathbb{S}} [y_j - y_j^d] d\phi_j$$

where $y_j^d = \xi \min\{y_{top}, y_j\}^{1-\tau} + (1 - \tau_{\max}) \max\{0, y_j - y_{top}\}$
$y_j = \mathbb{1}_{\{occup=worker\}} y_j^w + \mathbb{1}_{\{occup=entrepreneur\}} y_j^e + \mathbb{1}_{\{Retiree\}} y_j^r.$

3.3 Calibration

In this section, I discuss the parametrization of the model economy. The calibration procedure is then carried out in two steps: I first consider a set of fixed parameters drawn upon the literature (table 3.1) and thereafter I jointly calibrate the remaining parameters so that the model economy is consistent with a set of aggregate statistics of the US. economy (table 3.2). I use the PSID (1968-2011) and the SCF (2010) to compute some relevant statistics.

Table 3.1: Fixed parameters

Parameter	Symbol	Value	Source
Preferences, demographics and technology			
Risk aversion	σ	2.0	Conesa et al. (2009)
Lifetime	J	61.0	Average US data
Retirement	R	46.0	Average US data
Corporate capital income share	α	0.33	Gollin (2002)
Depreciation rate	δ	0.06	Stokey and Rebelo (1995)
Technology parameter	A_c	1.00	Normalization
Borrowing limit	λ	1.50	Kitao (2008)
Labor productivity			
productivity and process	η, P_η	–	Storesletten et al. (2004)
Age-dependent efficiency unit	$\{\epsilon_j\}$	–	own estimate using PSID
Government			
Government spending	G/Y	0.17	Conesa et al. (2009)
Replacement rate	τ_{rep}	0.40	Kotlikoff et al. (1999)
Consumption tax	τ_s	0.05	Imrohoroglu and Kitao (2010)
Tax progressivity	τ	0.17	Bakış et al. (2015)
Top marginal tax	$\tau_{\max}$	0.396	US data
Deduction rate for entrepreneurs	τ_d	0.00	US data
Average effective corporate tax rate	τ_c	0.29	Gravelle (2014)

3.3.1 *Preferences*

The relative risk aversion parameter σ is set to 2 following Conesa et al. (2009). The subjective discount factor β is jointly set to 0.951 so that, in equilibrium, the capital-output ratio is 2.65.

3.3.2 *Demographics and endowments*

Individuals enter the economy at real age 20 (model period 1) and live up to a maximum age of 80 years (model period $J = 61$). Since the mandatory retirement age in the US is 65, I allow agents to work until model period 45 and then retire at $R = 46$. Agents are endowed with one unit of time which they supply inelastically irrespective of the occupation.

Labor efficiency unit $\{\epsilon_j\}$ are computed using hourly earnings from the PSID and are intended to capture the standard hump-shape of the cross-sectional earnings profile. Earnings increase with age and during the prime-age but start declining after retirement. The idiosyncratic shock η takes on six possible values $\eta \in (\eta_1, \eta_2, \eta_3, \eta_4, \eta_5, \eta_6)$ where the first five are computed using an approximation of an AR(1) process after Tauchen (1986) as defined in section 3.2.2. Following estimations by Storesletten et al. (2004) I set the persistence coefficient ρ and the residual variance σ_η^2 to 0.95 and 0.03, respectively.[7]

However, the sixth productivity level η_6 is aimed at capturing an awesome state attainable with a small likelihood (Castaneda et al., 2003; Kaymak and Poschke, 2016). From any other state, η_6 can be reached with the same probability $\phi_{.6}$, but once individuals visit this state, they can only fall back to the medium ability η_3 with probability ϕ_{63}. Accordingly, one has to calibrate three parameters stemming from the workers' side : the two probabilities $\phi_{.6}$ and ϕ_{63}, and the awesome state η_6. The data moments as targets are the overall economy wealth Gini of 0.80, workers' total labor income Gini of 0.52 and the income share held by the top percentile of the income distribution which amounts to 20% in the (SCF, 2010).

On the other hand, the entrepreneurial ability is defined by four different values $z \in \{z_1, z_2, z_3, z_4\}$. I set the first one to 0 so that any individual with this ability will always choose to be a worker. By introducing an average ability $\bar{z}$ and a deviation ability $\hat{z}$, I relate the four abilities as $\{z_1, z_2, z_3, z_4\} = \bar{z} * \{0, 1-\hat{z}, 1, 1+\hat{z}\}$, where $\hat{z} \in (0,1)$, and therefore I am left with two abilities to calibrate. To ensure a parsimonious calibration of the transition probability P_z, I follow Kitao (2008) by assuming that agents can only move up and down to the closest state:

$$P_z = \begin{pmatrix} p_{11} & 1-p_{11} & 0 & 0 \\ p_{21} & p_{22} & 1-p_{21}-p_{22} & 0 \\ 0 & p_{32} & p_{33} & 1-p_{32}-p_{33} \\ 0 & 0 & 1-p_{44} & p_{44} \end{pmatrix}$$

The middle two rows probabilities are assumed to be identical, namely $p_{21} = p_{32}$ and $p_{22} = p_{33}$. I therefore calibrate the six parameters associated to the process of z, the span-of-control γ and the return to entrepreneurial human capital θ by matching eight targets in the steady state: the fraction of entrepreneurs in the economy, the average entry rate of workers into entrepreneurship, the average exit rate of entrepreneurs, the share of capital used in the entrepreneurial sector, the average tenure in the business sector, the share of income earned by entrepreneurs, the share of business income held by top entrepreneurs to that held by workers, and the ratio of entrepreneurs' wealth-income ratio to that of workers over the life-cycle.

[7]Using different models, Storesletten et al. (2004) find that ρ ranges from 0.94 to 0.96, and the variance lies between 0.014 and 0.04. I then take the average values of both estimates. This values are consistent with the range of estimates in the literature. For instance, $\rho = 0.94$ and $\sigma_\eta^2 = 0.016$ are found in Kaplan (2012).

Using the definition of an entrepreneur as a self-employed business owner who actively manages his venture, Cagetti and De Nardi (2006) find 7.5% of the US population falls in this category. The same characterization of an entrepreneur gives rise to 6.85% in the PSID and 8.48% in the SCF. Thus, I choose to target a middle figure of 7.5%. If one relaxes this definition by defining an entrepreneur as self-employed or business owner, the fraction of entrepreneurs can increase up to 12% (Quadrini, 2000; Gentry and Hubbard, 2004). The annual average entry and exit rates are set to 2.5% and 20%, respectively using the PSID (1968-2011). These targets are close enough to the 2.3% and 22% in Cagetti and De Nardi (2006). To capture the split of the economy in two sectors : corporations and incorporate businesses; I set the entrepreneurial capital share to 35% as Quadrini (2000). The panel nature of the PSID allows one to compute the average years an individual stays in entrepreneurship, I find seven years on average and then use it as a target. This data moment is clearly to help identify the contribution of the entrepreneurial specific human capital channel emphasized early on.

Some aspects of income property are also targeted. The model is required to match the share of income held by entrepreneurs of 20%. In Quadrini (2000), 12% of the population are defined as entrepreneurs and hold 22% of the income, but the lower fraction of entrepreneurs in my model leads me to choose a lower target of 20% which is consistent with their income share of 19.4% in the SCF (2010) . As seen in the income decomposition using the Theil index, the within-entrepreneur inequality is high enough. Therefore, I choose to target the fraction of business income held by the top 1% earners. I found in the SCF, a share of 39,95%. To discipline the model to capture a realistic degree of inequality seen in the data over the lifespan, I target the ratio of entrepreneurs' wealth-income ratio to that of workers over the life cycle. On average, the wealth-income ratio is 11.15 for entrepreneurs and 3.21 for workers using the PSID, while in the SCF 2010 one finds wealth-income of 10.66 for entrepreneurs and 3.65 for workers. Therefore, the ratio of the two occupations' wealth-income ratio is 2.9 and 3.4 for the PSID and the SCF, respectively. I then choose to target a conservative figure of 3. One rationale guiding this choice is to allow the model to capture the persistent inequality over the life cycle between the two occupations.

The current baseline admittedly relies on one more channel, namely the accumulation of entrepreneurial experience to analyze the entrepreneurial dynamics and wealth implication. Therefore, to cast more light on this avenue, I recalibrate the model without human capital accumulation by targeting 11 moments out of the previous 12 moments. Indeed, the absence of the experience return θ reduces this number, and I dropped the average business tenure as a moment.

Table 3.2: Jointly calibrated parameters

Parameter	Symbol	Value
Labor productivity process		
higher productivity level	η_6	21.75
probability of reaching this state from anywhere	$\phi_{.6}$	0.003
Median-reverting probability	ϕ_{63}	0.128
Entrepreneurial ability process		
Entrepreneurial ability levels	$\bar{z}$	1.150
	$\hat{z}$	0.213
Transition probabilities	p_{11}	0.987
	p_{21}	0.487
	p_{22}	0.313
	p_{44}	0.702
Remaining parameters		
Discount factor	β	0.951
Span-of-control parameter	γ	0.830
Return to entrepreneurial experience	θ	0.236

3.3.3 *Technology and market arrangement*

In the corporate sector, the share of output that goes to the capital α is set to 0.33 as is standard in the macro literature (Gollin (2002)). The productivity parameter A_c is normalized to unity. Capital depreciates in both sectors at the same rate δ which I fix to a standard value of 6% (Stokey and Rebelo (1995)).

One important aspect of entrepreneurship if the existence of financial constraint that could prevent one from starting or expanding a venture. Empirical estimations such as Evans and Jovanovic (1989) have shown the relevance of such constraints.[8] The financial sector then allows entrepreneurs to borrow up to a fraction $\lambda = 1.5$ of their assets.

[8]The relevant of borrowing constraint is extensively used in quantitative macro models (Kitao, 2008; Buera, 2009), and references therein). However, Hurst and Lusardi (2004) challenged this view by arguing that borrowing constraint are non active for households below the 95% of the wealth distribution. Then the entry probability is only increasing with wealth for households in the top-end 5% of the wealth distribution.

3.3.4 Government and tax system

Government consumption is set to 17% of the output following Conesa et al. (2009). This outlay is funded by consumption and income tax proceeds. I fix the proportional consumption tax τ_c to 5% (Imrohoroglu and Kitao (2010)). The income tax progressivity τ in US economy estimates from Bakış et al. (2015), Heathcote et al. (2014a) lie between 17% to 18.5%. I use the lower bound of these estimates in the benchmark economy as in Bakış et al. (2015).

Table 3.3: Goodness of fit

	Data	**Model**	%Error
Capital-output ratio	2.65	2.60	-1.88
Overall wealth Gini	0.81	0.82	1.23
Income Gini for workers	0.52	0.52	0.00
Income share for top earners (%)	20.0	20.4	2.00
Fraction of Entrepreneurs (%)	7.50	7.10	-5.33
Entry rate into entrepreneurship (%)	2.50	2.60	4.00
Exit rate from entrepreneurship (%)	20.00	20.90	4.50
Average Tenure in Entrepreneurship (years)	7.16	8.00	11.11
Non-corporate capital share (%)	35.00	35.6	1.71
Business income share for top Entrepreneurs (%)	40.00	37.0	-7.50
Entrepreneurs' share of Total income (%)	20.00	20.8	4.00
Wealth-Income ratio (Entrepreneur to Worker)	3.00	2.75	-8.33

Table 3.3 summarizes the performance of the model economy with respect to the data targets. Overall, the model has a good fit.

3.4 Optimal taxation problem

Given the optimal behavior of agents from the competitive equilibrium, a benevolent Ramsey planner seeks a flat tax τ_e for entrepreneurs in order to maximize the average utilitarian welfare under revenue neutrality. Let $x = (a, z, \eta, \kappa, o, j)$ a state for a given individual in the economy, $\mathcal{V}(x)$ her lifetime value functions and $\phi(x)$ the corresponding distribution. Under the differential taxation scheme, entrepreneurs are entitled to pay a proportional tax on their business income while workers and retirees are still subject to progressive taxation as in the benchmark economy. I assume that planner equally weighs all individuals ' welfare in the economy. The planner's problem formally is as follows[9]

$$\mathcal{W}_{ss}(\tau_e) = \int \mathcal{V}(x, \tau_e) d\phi(x) \tag{3.24}$$

$$\tau_e^* = \text{argmax}\, \mathcal{W}_{ss}(\tau_e) \qquad \text{subject to} \tag{3.25}$$

$$G + B = \tau_c \tilde{r} K_c + \tau_s \int_{\mathbb{X}} c(x) d\phi(x) + \int_{\mathbb{X}/E} [y(x) - y^d(x)] d\phi(x) + \tau_e \int_E y^E(x) d\phi(x) \tag{3.26}$$

with $\mathbb{X}/E$ the entire state space excluding entrepreneurs while E is the corresponding space for entrepreneurs.

To explicitly gauge the effect of the transition path on the optimality outcome, I assume an unanticipated reform at period 0 inducing the economy to undergo a transit into the new steady state. One can then identify the welfare for generations alive at the reform year as well as that of future generations. The modified problem of the planner is :

$$\max_{\tau_e} \mathcal{W}(\tau_e) = \int \mathcal{V}_0(x, \tau_e) d\phi_0(s) + \sum_{t=1}^{\infty} \beta_g^t \int \mathcal{V}_t(x_0, \tau_e) d\phi_t(s) \tag{3.27}$$

subject to

$$G + B_t = \tau_c \tilde{r}_t K_t^c + \tau_s \int_{\mathbb{X}} c_t(x) d\phi_t(x) + \int_{\mathbb{X}/E} [y_t(x) - y_t^d(x)] d\phi_t(x) + \tau_e \int_E y_t^E(x) d\phi_t(x) \tag{3.28}$$

and the agents' competitive decisions indexed by time subscript t. The separation between *short-run* and *long-run* cohorts is affected by the planner's discount factor($\beta_g \in [0, 1)$).[10] When $\beta_g = 0$, only current generations are valued by the planner. But the very future generations are a priority if $\beta_g \to 1$, mimicking somehow the steady-state welfare maximization.

[9]Utilitarian welfare function can also be considered from an *ex-ante* perspective of a newborn as in Conesa et al. (2009). Let define $x_0 = (0, 0, \eta_{median}, 1, work, 1)$ the state of a newborn into the economy. Here, I assume that the newborn (j=1), has zero net worth (a=0), enters the labor market with the median work ability($\eta = \eta_{median}$) and no entrepreneurial skill ($z = 0$) with a normalized entrepreneurial human experience of one($\kappa = 1$). The planner's problem then becomes :

$$\tau_e^* = \text{argmax} \int \mathcal{V}(x_0, \tau_e) d\phi(x_0) \qquad \text{subject to (3.26)} \tag{3.23}$$

[10]There is not an established way of choosing a specific value for this parameter. While Bakış et al. (2015) allow its value to vary, Kindermann and Krueger (2014) and Fehr and Kindermann (2015) use the value $\beta_g = 1/(1 + r_{ss})$ with r_{ss} the benchmark steady-state interest rate.

Table 3.4: Aggregates under optimal flat rate regime (long run)

Variables	GE	PE
	%Δ from benchmark	
Output	0.19	-0.32
corporate	4.08	6.17
non corporate	-3.07	-5.76
Capital	2.82	-1.66
corporate	2.84	2.00
non corporate	2.78	1.03
labor	1.15	1.34
corporate	4.72	8.38
non corporate	-2.46	-5.76
Prices		
after-corp-tax interest rate	3.48	0.00
wage	-0.63	0.00

GE stands for general equilibrium and PE, for partial equilibrium.

3.4.1 *Optimal tax reform along the transition*

The main experiment in this paper is to find the level of the proportional tax rate for business owners, accounting for the transition from the current U.S. baseline. Before this exercise, I first look at the desirability of a differential taxation based on occupation in the long run.

Overview on optimality in the long run

In the steady-state analysis, I find an optimal tax rate of 25% when the planner solves his program as specified in equations (3.24) - (3.26). This rate induces a GDP decline and a welfare loss in the new economy.[11] Table 3.4 illustrates that the direct effects of the proportional tax (partial equilibrium) are negative. Indeed, output is reduced by 0.32% and capital by 1.66%. Nonetheless, the factor price adjustment reverses these negative effects by raising the output and capital stock by 0.2% and 2.8%, respectively.

Entrepreneurial sector underperforms in this optimal scenario. This seems counter-intuitive since one would expect that linear tax is prone to reduce distortions, which

[11] If one solves the planner's problem for the newborn as defined in (3.23), the optimal tax drops to 11% and still generates a welfare loss around 3.7%. Nonetheless, at this rate the entrepreneurial sector is taking advantage of the lower tax liability to increase investment, which leads to 3% increase in aggregate output.

will incentivize individuals to engage in entrepreneurship and boost production and employment.[12] Accordingly, the performances of the entrepreneurial sector are laid out in Appendix 4.8.1 and reveal a 20% stark decrease of the entrepreneurs' fraction in the population coupled with a lower entry rate. Also, the reduction by 0.6% in wage is not enough to overcome the stringent borrowing constraints induced by the 3.5% hike in the after-tax interest rate. Although the remaining pool of entrepreneurs operates on average larger firms as compared to the benchmark, the fall in entrepreneurial total investment is still severe. The negative extensive margin in this scenario dominates the positive one induced by larger investment. Indeed, under the proportional tax regime, all entrepreneurs pay the same average tax rate whereas 44% of entrepreneurs do not pay an average tax higher than the optimal rate in the benchmark economy. Therefore, wealth-poor entrepreneurs leave the business sector while wealth-poor workers reduce their entry into entrepreneurship. This can be clearly seen in table 3.5 where the fraction of middle-class entrepreneurs[13] shrinks considerably meanwhile that of top 1% wealthier entrepreneurs remains stable. In fact, the higher burden deters entrepreneurship for middle-class entrepreneurs since there is no longer a strong insurance channel to dampen the risky feature of entrepreneurial activities.[14]

In Appendix 4.8.1, I also provide the dynamics of the aggregates variables form the benchmark economy to the optimal steady state. This helps understand the effect of the transition on welfare. Provided the aggregates variables of the economy do not adjust instantaneously, current cohorts suffer less from a reduction of consumption. They also

[12]For instance, Kitao (2008) finds that a 10% flat tax rate (not optimized) solely applied to business income, increases output by 5% and capital stock more than 10%. One channel that may explain the divergent outcomes with respect to the current paper is the infinite horizon feature in her paper. In fact, the OLG assumption made in the present framework prevents individuals to indefinitely take on more risky activities given they are risk averse and also that, absent progressivity for entrepreneurs the transfer channel is cut, making entrepreneurial sector riskier. Moreover, retirees live partially off their accumulated asset. In expectation then, this precludes individuals to fully engage in the business sector over their life cycle. Further, the results in Bohácek and Zubrický (2012) show that, flat taxation in occupational model with various tax deductions is also pro-growth and welfare-improving for the U.S. economy even though it reduces entrepreneurial population. However, their flat tax is not based on income source as in this paper, but is equally applied to both workers and entrepreneurs.

[13]The "middle-class" in the income or wealth distribution is not clearly defined in the literature, but here I consider as middle-class those between the 50th to the 90th percentile.

[14]This channel is found important in explaining for instance positive capital taxation with risky investment in Panousi and Reis (2012). Indeed, they find that under a certain range of business income variability, a positive capital taxation incentivizes agents to undertake entrepreneurial activities and increase capital accumulation since the insurance mechanism is stronger. Panousi (2012) even finds efficient taxation close to 50% capital tax rate.

face lower tax liabilities and experience much lower welfare loss (-1.75%) as compared to long-run generations(-3.7%).

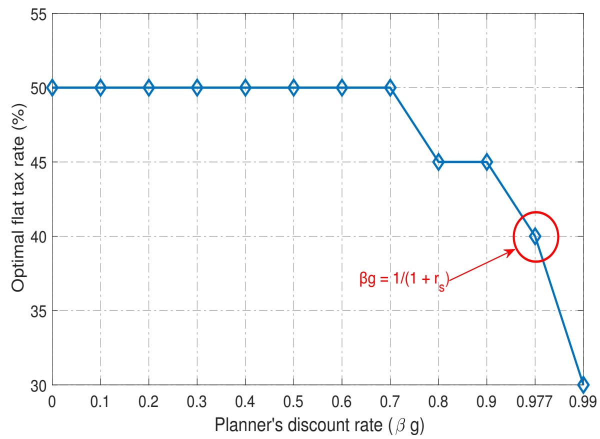
Table 3.5: Distribution of entrepreneurs across wealth

	wealth percentiles				
% of entrepreneurs	All	0.10-0.50	0.50-0.90	0.90-0.99	1%
Benchmark	7.10	0.09	11.01	25.30	41.00
Optimal	5.78	0.03	7.10	27.55	41.71
Avg. Investment					
Benchmark	13.69	0.623	4.238	21.263	65.886
Optimal	17.28	0.309	4.726	22.091	73.571

Optimality with utilitarian planner along the transition

Departing from the benchmark economy, to what extent a utilitarian planner should tax business owners accounting for transition and well-being of future generations? To answer this question, I assume that the economy is initially at the benchmark steady-state and the government surprisingly changes the tax schedule with a *once-and-for-all* commitment, thereby making the economy to start transitioning into the new steady state. For each flat tax rate $\tau_e (\in \mathbb{R})$ and the induced transition path, the planner computes the utilitarian welfare function as defined in (3.27). Subsequently, he chooses the tax rate maximizing this welfare. Current cohorts are weighted equally. Any reform undertaken is assumed to be revenue neutral. In particular, the progressive part of the tax code (captured by the parameter τ) remains the same as in the benchmark, but the parameter ξ is used to balance the government budget and generate as much revenue in the counterfactual economy as in the benchmark. Recall that this parameter controls for the average taxation in the economy.

Figure 3.1: Government's discount factor and Optimality

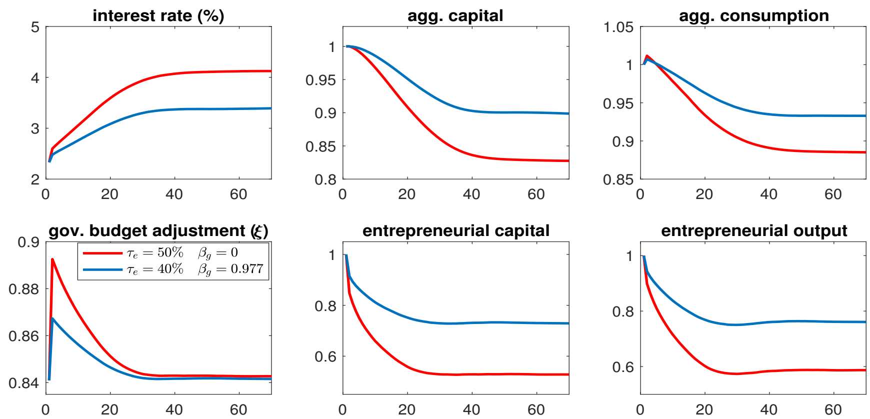


Since the value of the government's discount factor can lie anywhere in $[0, 1)$, figure 3.1 gives a perspective on the effect of the weight of the future cohorts on the optimality. Specifically, there is a decreasing function between the optimal tax set by the planner and his valuation of future generations. Up to a degree of $\beta_g = 0.7$, the optimal tax is 50% because the welfare of future newborns is still dominated by that of the cohorts alive at the time of the reform. But the more the government is future-oriented, the larger the drop in the optimal tax rate. Absent future generations, the planner confiscates much revenue from the wealthy (namely, entrepreneurs) to be redistributed to income-poor agents, thereby increasing the average welfare.[15] However, the potential distortion on the capital accumulation dictates a lowering of the tax rate when *long-run* enters into consideration. This result is consistent with what found in an environment without entrepreneurship by Bakış et al. (2015), where they also show a downward sloping trend between discount factor and optimal progressivity.[16]

[15]Using a similar model as Conesa et al. (2009), but accounting for transition, Fehr and Kindermann (2015) find an optimal capital income tax of 49% for *short-run* cohorts.

[16]In fact, they find that if the planner is highly altruistic then the tax code turns out to being regressive. Typically, the tax progressivity parameter τ goes down form 0.16 to -0.09.

Figure 3.2: Evolution of aggregate quantities: Effect of the discount factor



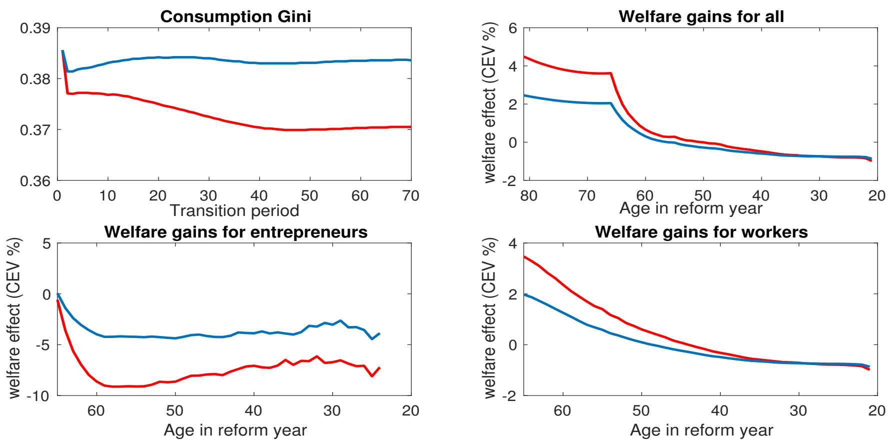
Note: Transition to two differential taxation economies - values relative to the benchmark economy, except for r and the parameter ξ balancing the government budget. Blue line: optimal economy with 40% tax rate and strong weight($\beta_g = 0.977$). Red line : optimal economy with 50% tax rate with no discounting ($\beta_g = 0$). The years of transition are on the x-axis.

I choose two levels of discount factor to conduct a parsimonious analysis. The natural one is when planner only considers *short-run* cohorts, namely by putting $\beta_g = 0$. The second level has a strong weight on future cohorts' well-being and is set to $\beta_g = 0.977$.[17] Accordingly, figure 3.2 depicts the dynamics of main macro variables under the two optimal tax rates. The sharp difference between the two simply emphasizes the role of the planner's discount factor. Higher discounting recommends lower tax rates to limit the decumulation of capital stock along the transition. Moreover, the entrepreneurial sector is distorted in both regimes, but more so in the 50% regime. The increase in the tax burden for business owners disincentivizes them to undertake or scale up entrepreneurial activity since entrepreneurship now occupies only 3.2% of the population (down from 7.5% in the baseline). Consequently, the aggregate capital drops heavily inducing a rise in interest rate. In the first period however, consumption increases since the planner by seizing a large revenue from capital can relax the average tax in the economy by raising the government balancing parameter ξ. The need to balance the budget each period leads to an increase in the average tax in the economy during the following periods. This is done by lowering the parameter ξ which is larger in the 50% scenario. Intuitively, lower capital generates lower revenue and with revenue neutrality assumption, the government

[17] This value is based on suggestion by Kindermann and Krueger (2014) and Fehr and Kindermann (2015) who restrict themselves to $\beta_g = 1/(1 + r_{ss})$, with r_{ss} the benchmark steady-state's interest rate. My model delivers an interest rate $r_{ss} = 2.323\%$ which induces a value of $\beta_g = 0.977$. Therefore, if not specified otherwise, these values will be used in the rest of the paper.

needs to raise the average tax on the economy.

Figure 3.3: Inequality and welfare effect



Note: Transition to two differential taxation economies. Blue line: optimal economy with 40% tax rate and strong discount (β_g = 0.977). Red line : optimal economy with 50% tax rate without discount(β_g = 0).

I now turn to the distributional effects of implementing such optimal policies for the population alive at the reform period. One way to assess the effect of the tax reform on *ex-post* inequality is by looking at the consumption Gini coefficient. As shown in figure 3.3, the first period experiences a drop in consumption inequality, testifying indeed the implicit nature of the redistribution embedded in the utilitarian welfare function used so far. The inequality drop is pronounced when there is no weight since the cohorts alive at the time of reform receive a large reduction in their effective tax (increase in ξ). Meanwhile, consumption inequality starts rising in the subsequent periods of the transition in the discounting case; the 50% tax rate on business owners sustains a further decrease in this inequality. Intuitively, this follows the fact that the average tax burden in the 50%-economy is lower than the one in the alternative economy (see the difference in the ξ_s in figure 3.2).

It is also important to disaggregate the welfare effect with respect to the life-cycle feature of the current framework. In both scenarios, welfare costs are positive for individuals under age 40. In fact, higher tax on business owners makes capital scarce which induces a hike in the interest rate and a fall in wage. Individuals over 40 have had time to accumulate risk-free asset which now receives a windfall income stemming from the rise in the interest rate. Therefore, lower average tax rate coupled with higher returns on savings make older agents better-off. On the other hand, agents under age 40 rely heavily on labor income, but provided that wage is falling they are exposed to lower consumption, hence lower welfare. One can notice that during this part of the life cycle, the welfare gain with weight for futur cohorts is relatively higher (and almost positive) than that of the no-discounting scenario. This is due to the lower amplitude of the wage decrease when the planner cares strongly about future generations. Over the entire life cycle, entrepreneurs are worse-off on average. Either 40% or 50% as a tax rate on businesses reduce their ability to keep enough income to consume after defraying business costs. As a result, their savings are crowded out. They no longer benefit from the progressivity of the tax code that would have hampered the risky feature of entrepreneurship. Those remaining business owners given their work and entrepreneurial ability, find it optimal to stay in the business sector to the extent that the outside option as worker is not attractive, albeit in presence of higher taxation regimes.

Table 3.5 finally reports the average welfare by occupation and particularly identifies those who are in favor of such differential policies. Workers and retirees' political support decreases when planner's put weight on future cohorts' welfare, which is the opposite for entrepreneurs. Intuitively, higher tax on entrepreneurs reduce tax progressivity on workers and retirees and this translates to more income to consume. Even absent altruism, the support by workers as a group is just above the majority suggesting that the reduction of labor income through the capital stock decumulation is still hurting the economy. Consequently, the economy as a whole does not have a strong political support. I then move one step further to investigating the equity and efficiency trade-off.

Table 3.6: Aggregate welfare gains and Support

Planner's discount factor	Optimal tax	Average gains(%)			Support(%)		
β_g	τ_e^*	Workers	Entrep.	All (+Retirees)	Workers	Entrep.	All (+Retirees)
0.000	0.50	0.32	-7.27	0.92	51.52	7.62	56.60
0.977	0.40	-0.08	-3.45	0.34	34.63	43.10	50.94

Support: fraction of individuals with welfare gains

3.4.2 *Optimality and Efficiency*

The utilitarian planner has a strong motive for redistribution and would like to set higher tax rates on wealthy individuals in order to increase transfers to the poorer. This is a direct implication of the concavity of the individuals' utility function. In doing so, this fact triggers a trade-off between equity and efficiency. To the extent that the current framework embeds entrepreneurship, it would then be worth understanding the level of taxation on the pure efficiency basis. I follow the aggregate efficiency criterion introduced by Benabou (2002) and used in recent work with different environments (Bakış et al., 2015; Dyrda and Pedroni, 2016; Heathcote et al., 2017).

Let $\mathcal{V}(x, \tau_e)$ the expected lifetime utility of an individual of age j with $x = (a, z, \eta, o, j)$ as a state variable, namely before the realization of idiosyncratic shocks (z, η). The corresponding certainty equivalent level of consumption delivering this utility is denoted by $\bar{c}(x)$. Considering $\bar{C}_{jt}(x)$ the average age$-j$ certainty equivalent consumption and $\mathbb{V}_j(\tau_e)$ as the age-j welfare associated to this consumption level at period t, one can write

$$\bar{C}_{jt}(\tau_e) = \left(\int \bar{c}(x)^{1-\hat{\sigma}} d\phi_j(x) \right)^{\frac{1}{1-\hat{\sigma}}} \tag{3.29}$$

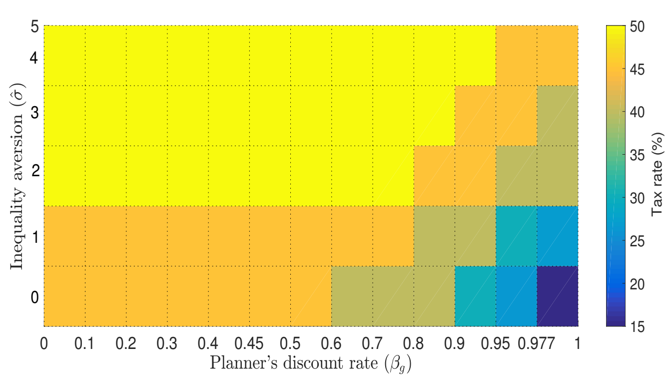
$$\mathbb{V}_{jt}(\tau_e) = \frac{\bar{C}_{jt}(x)^{1-\sigma}}{1-\sigma} \tag{3.30}$$

The planner's objective function then becomes :

$$\mathcal{W}^{\hat{\sigma}}(\tau_e) = \sum_{j=1}^{J} \beta^{j-1} \mathbb{V}_{j0}(\tau_e) + \sum_{t=1}^{\infty} \beta_g^t \mathbb{V}_{0t}(\tau_e) \tag{3.31}$$

The parameter $\hat{\sigma} \in \mathbb{R}^+$ is the planner's degree of aversion to within-cohort inequality. When the planner is guided only by efficiency motive, he is zero-inequailty averse, namely $\hat{\sigma} = 0$. On the other hand, a very strong taste for redistribution is present with $\hat{\sigma} \to \infty$, and mimics the Rawlsian case. Particularly, if $\hat{\sigma} = \sigma$, where σ is the individuals' risk aversion then the planner is simply utilitarian.

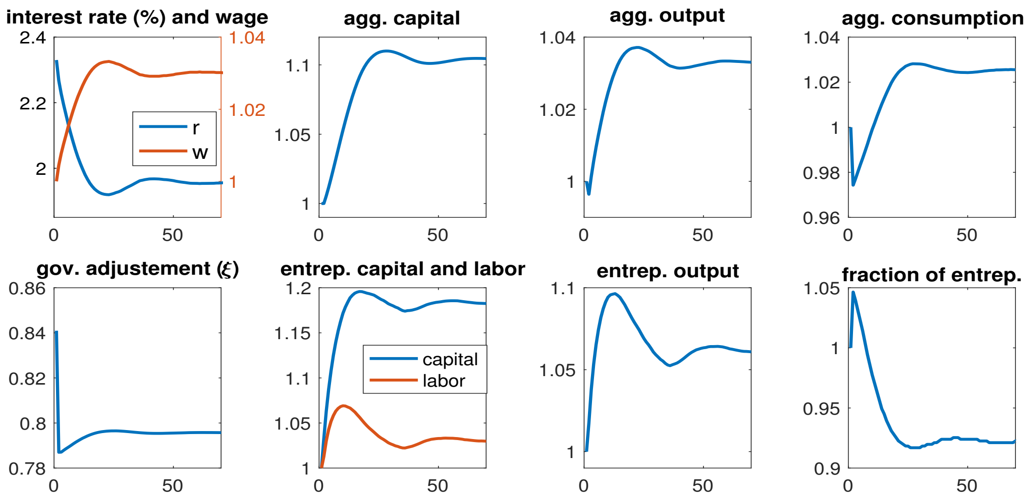
Figure 3.4: Opitmality as a function of Inequality aversion and discount factor:



As shown in equation (3.31), the consideration of future generation puts altruism as secondary instrument for the planner. Accordingly, figure 3.4 shows the way the two instruments affect optimality. Two results can be underscored from this graph. Firstly, there is a positive relationship between tax rate and inequality aversion. This result is reminiscent of alternative environments without entrepreneurship (Dyrda and Pedroni (2016), Heathcote et al. (2017)). For instance, an efficiency-oriented planner with no altruism ($\hat{\sigma} = 0, \beta_g = 0$) chooses 45% as optimal tax while the utilitarian one as in section 3.4.1 ($\hat{\sigma} = \sigma = 2, \beta_g = 0$) sets his to 50%. Secondly, the other outcome stemming from figure 3.4 is that the tax rate is decreasing in altruism. Indeed, for a zero inequality-aversion planner, the tax drops from 45% to 15% whereas the utilitarian reduces it to 30% from 50%. Arguably, for efficiency purpose in the *long run*, the planner would like a 5%-15% point reduction margin in the optimal tax rates.

In the following discussion, I set as in section 3.4.1 the discount factor to $\beta_g = 0.977$ when a planner is inequality-free. The optimality in this case is a flat tax rate of 15% for entrepreneurs. Under these conditions, figure 3.5 illustrates the dynamics of macro-variables over the transition period. Without no surprise, a trade-off in favor of efficiency generates higher output, capital stock, and consumption. In fact, the new 15% as tax rate on business income relaxes borrowing constraints on entrepreneurial investment (positive intensive margin) which soars up to 10%. Higher capital stock induces a lowering in interest rate and a rise in wage up to the 20th period of transition before a small reversion in this trend. One can notice that even with the lower tax rate there is 8% reduction in the fraction of entrepreneurs (negative extensive margin) in the long run. Indeed, all entrepreneurs are not wealthy and 45% of entrepreneurs were paying an average tax rate less than the optimal tax rate of 15% in the benchmark economy. Since the cost of entrepreneurship becomes higher those business owners exit. Thus, they contribute to depressing the saving rate of entrepreneurs as a group. As a result, the negative extensive margin outweighs the positive intensive one, thereby dampening capital accumulation both at the entrepreneurial and aggregate levels. Moreover, the drop in consumption in the first period is related to the large decrease in the parameter ξ balancing the government budget. The lower this parameter, the higher the average tax in the economy. Thus, with reduced disposable income agents consume less. Subsequently, the value of ξ stays far below its pre-reform level because entrepreneurs are no longer part of the progressive tax code and revenue neutrality must be satisfied (cost borne by workers and retirees). Efficiency guarantees higher capital stock for future generations.

Figure 3.5: Evolution of aggregate quantities in case of efficiency ($\hat{\sigma} = 0$)



Note: Transition to efficiency - values relative to the benchmark economy, except for r and the parameter ξ balancing the government budget. The years of transition are on the x-axis.

Although the main focus of the planner in this scenario is efficiency, I provide here an overview of the change in inequality and welfare. One sees readily from figure 3.6 that, the absence of redistribution mechanically raises inequality within and across generations. For instance, consumption and wealth Gini coefficients increase by 8% and 3% in the final steady state, respectively. In fact, the rise in the average tax reduces disposable income for income-poor agents which contributes to increasing consumption disparity. Consequently, they also reduce their savings exacerbating therefore wealth inequality. This situation leads to welfare losses with respect to the *status quo*. Working-age individuals face lower wage rate inducing an average 4% welfare loss in consumption. Since retirees face relatively lower returns on their savings and a reduction in their pension benefit, their loss is decreasing towards the end of the life cycle. Young entrepreneurs under age 30 are also worse-off given that they are yet to build up necessary savings in their risky activity. After this threshold, they start taking advantage of the new tax incentives. Nonetheless, over the life cycle, only entrepreneurs amongst the top 1% wealthy are better-off. As a result, there is a lopsided support for this reform in the current generation as shown in table 3.7. With less than 5% of the total population's support, this policy may be politically infeasible.

Figure 3.6: Inequality and welfare effects

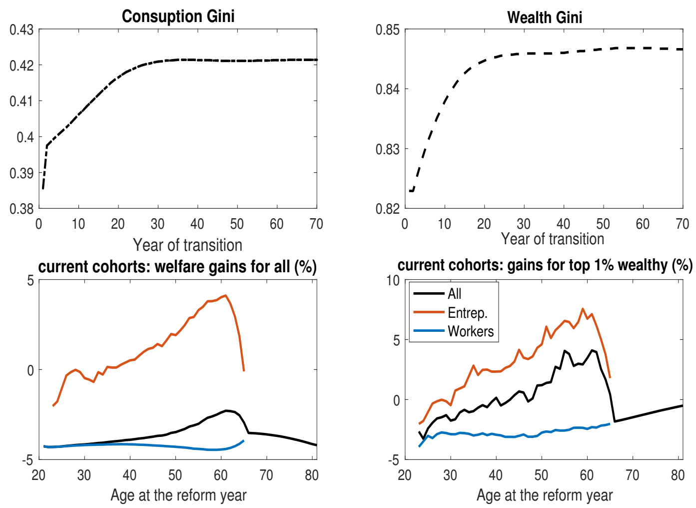


Table 3.7: Welfare gain by occupation and wealth group (%)

	All	< 0.50	0.50-0.90	0.90-0.99	1%
Workers	-4.25	-4.36	-4.14	-3.29	-2.43
Support	0.10	0.00	0.12	0.73	2.24
Entrepreneurs	2.44	-4.85	0.56	5.29	4.74
Support	55.00	0.00	41.50	75.00	73.24
All (+ retirees)	-3.63	-4.51	-3.38	-0.29	0.93
Support	4.20	0.00	4.88	22.74	32.98

3.5 Discussion

In this section, I investigate whether the financing mode or the entrepreneurial experience have an effect on the optimality results. In doing so, I first run the experiment using a consumption tax to balance the government budget, instead. Thereafter, I consider an alternative framework where the entrepreneurial experience's channel is absent.

3.5.1 *Financing with consumption tax*

Reforming the income tax code using consumption tax has often focused the attention of tax debates.[18] Therefore, to add to this discussion, I allow the consumption tax to be adjusted in order to balance the government budget while the income differential taxation between occupations is implemented. In fact, the benchmark level of government spending (G) as well as the adjustment parameter (ξ) is maintained fixed whereas the consumption tax (τ_s) is adjusted under revenue neutrality.

Panel (a) of figure 3.7 readily shows that results are qualitatively similar between the two scenarios : optimal tax decreases with the degree of the planner's discount factor. However, quantitatively, the optimal proportional tax to apply to entrepreneurs is lower when consumption tax is used. For instance, the optimal tax is set to 45% with consumption tax absent accounting for long-run cohorts, instead of 50% in the alternative case. With $\beta_g = 0.977$, the optimal tax becomes 27% in lieu of 30%. The intuition underlying this result is that taxing consumption is an alternative way of reducing tax on savings. Since entrepreneurs have relatively higher saving rate, this consumption taxation then induces a lower tax on business owners as a group. Given an optimal tax rate, the consumption tax adjusts under revenue neutrality over the transition path. In panel (b) are graphed the dynamics of consumption tax when the degree of altruism β_g takes value 0 and 0.977. Without altruism ($\beta_g = 0$), consumption tax falls from 5% to 1.4% in the first period to the extent that the optimal tax of 45% is already high for entrepreneurs to bear. In the subsequent periods of the transition path, the consumption tax increases but stays below its baseline value. In reverse, with an altruistic planner the optimal tax on business owners is set to a lower value of 27% because of capital formation purpose. However, this trades off with a hike in consumption tax over periods.

An overview of the welfare consequences of this alternative tax reform is provided in table 3.8. As stated in previous sections, I also find in this alternative case that welfare gains and political support decrease with altruism for workers and retirees while the opposite holds for entrepreneurs (line 2 vs line 4). Indeed, absent altruism business owners face a higher tax rate which induces a fall in the consumption tax. To the extent that workers and retirees allocate more of their income to consumption, the drop in consumption tax is then a direct channel to increase their well-being. This situation reverses when altruistic planner set lower tax on entrepreneurs which is paid for by an increase in consumption tax.

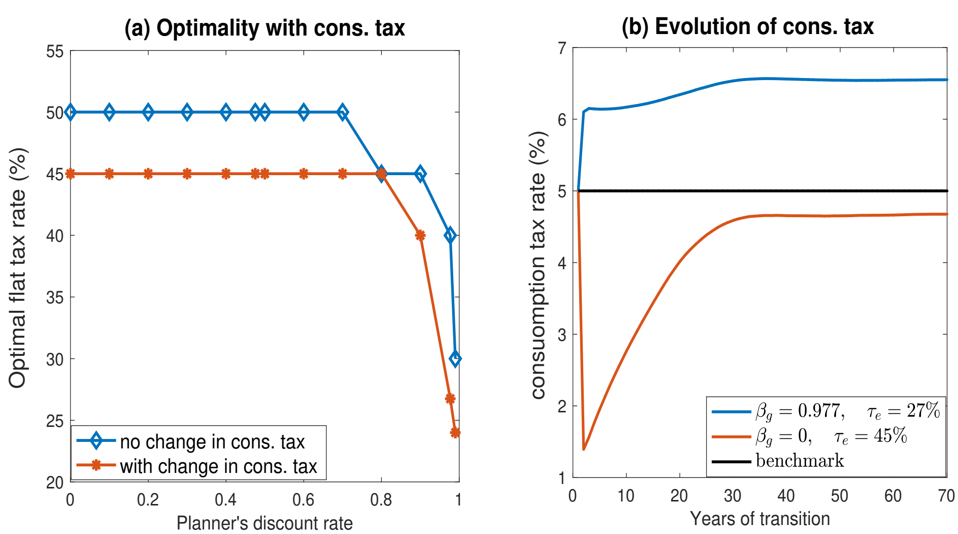
[18] See Zodrow and Mieszkowski (2008) for a recent review.

Next, when comparing for a given weight the two scenarios it follows that: workers and retirees are better-off under the tax reform without a change in consumption tax meanwhile business owners prefer a reform financed by a consumption tax. This resonates with the intuition that poor-income individuals are likely to suffer the most from a replacement of the income tax system by a consumption tax.

Table 3.8: Aggregate welfare gains and support with consumption tax

		Optimal taxes	Average gains(%)			Support(%)		
Planner's discount factor	Model	τ_e^* and τ_s^*	Workers	Entrep.	All (+Retirees)	Workers	Entrep.	All (+Retirees)
$\beta_g = 0$	without $\Delta\tau_s$	$\tau_e^* = 50\%$, $\tau_s^* = 5\%$	0.32	-7.27	0.92	51.52	7.62	56.60
	with $\Delta\tau_s$	$\tau_e^* = 45\%$, $\tau_s^* = 1.40\%$	-0.30	-4.18	0.55	28.60	21.10	47.00
$\beta_g = 0.977$	without $\Delta\tau_s$	$\tau_e^* = 40\%$, $\tau_s^* = 5\%$	-0.08	-3.45	0.34	34.63	43.10	50.94
	with $\Delta\tau_s$	$\tau_e^* = 27\%$, $\tau_s^* = 6.11\%$	-1.43	0.05	-1.15	0.30	44.48	3.31

Figure 3.7: Planner's discount factor, optimality and consumption tax



3.5.2 *Effect of entrepreneurial human capital*

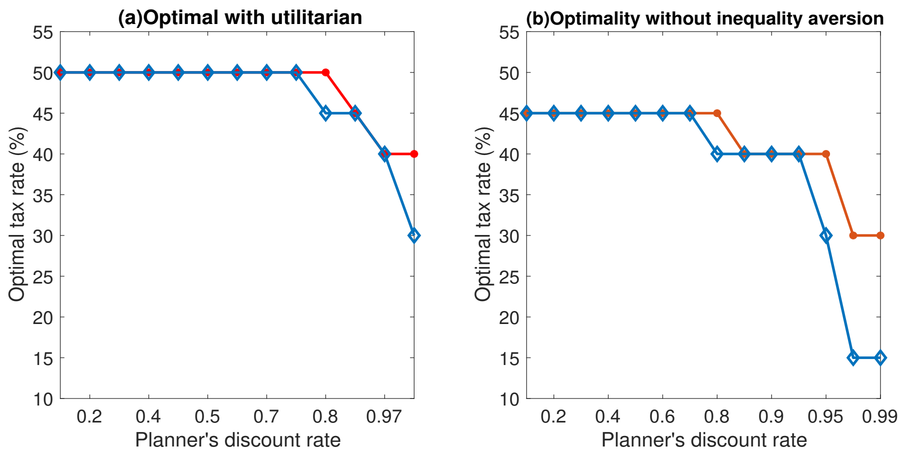
This paper emphasizes the importance of entrepreneurial experience as an intangible asset in the dynamics of entrepreneurship. For instance, the presence of this asset helps sustain a realistic distribution of entrepreneurs across wealth percentiles. But to understand to what extent this consideration might affect the results in the previous sections, I rerun the same experiments in a recalibrated version of the model without this channel.

Below I show in the first panel of figure 3.8 how the degree of altruism affects optimality in both models. Up to a discount factor of $\beta_g = 0.7$, both models predict an optimal proportional tax rate of 50% entrepreneurs. However, the presence of entrepreneurial experience induces a lowering of the tax rate once the planner's weight starts rising above 0.7. For instance, when this degree is approximately equal to one, there is a 10 percentage point difference between the two models.[19] Intuitively, the planner who cares strongly about future generations would like to keep providing more incentives for entrepreneurs to stay longer in the business sector and increase capital stock. Since entrepreneurial experience is a valuable intangible asset for business owners, a lower tax rate is a rational consequence. On the other hand, absent altruism the channel of entrepreneurial experience is not effective because current generations are preoccupied with their higher present consumption, and becoming a tenured business owner via savings is no longer attractive.

When I turn to considering a planner with zero-inequality aversion and altruism $\beta_g = 0.977$, I find that the optimal tax rate is now 25% (second panel of figure 3.8). Recall that in the same scenario with entrepreneurial experience, the optimal flat tax rate is 15%. This discrepancy then emphasizes the role of the intangible asset in designing the optimal business income policy. Indeed, the valuation of experience in the business sector incentivizes entrepreneurs to stay a bit long given that their accumulated human capital is an essential input subsequently. As a consequence, staying longer in the business sector will trigger a relatively higher saving rate which is necessary to increase capital stock and aggregate output. And provided that entrepreneurship is also a risky activity, the planner is willing to reduce more the tax rate for efficiency purpose in the model with human capital accumulation as compared to that without this channel.

[19] One can notice that for my preferred degree of altruism $\beta_g = 0.977$, the two models predict the same optimal tax rate of 40%. This exercise resembles to some extent to that in Badel and Huggett (2014), where they show that the consideration of investment in human capital reduces the optimal tax in a model without occupational choice. In the current setup, the effect of entrepreneurial human capital is sensitive to the type of social welfare function used by the planner.

Figure 3.8: Planner's discount rate, optimality and business experience



3.6 Conclusion

In an overlapping generations environment featuring occupational choice between paid-work and entrepreneurship, I quantitatively characterize a Ramsey-style optimal tax policy while taking into account the entire transition path. The planner sets a flat tax rate to be solely applied to business owners whereas workers and retirees are still subject to the progressive tax code. Changing the actual U.S. neutral personal tax code to an optimal dual taxation system based on agents' occupations generates mixed results.

I find that it is desirable to impose a flat tax rate of 40% on business income. However, at this rate, operating a business becomes costlier for entrepreneurs who exit to a large extent the business sector. Therefore, the investment and output plummet. The induced welfare gain from such a reform is small and is almost captured by older workers and retirees in the current generation. The optimal tax rate is sensitive to the planner's discount factor to the extent that absent intergenerational consideration, the optimal tax rises to 50%. Indeed, with a strong motive for redistribution, the utilitarian planner would like to tax at higher tax rate business owners since they hold a large share of the economy's capital. In doing so, the current generation is better off at the detriment of future generations who will inherit of low capital stock due to lower capital accumulation by entrepreneurs. As a general result, the optimal flat tax rate is decreasing in the weight the planner gives to future cohorts, but is an increasing function of his aversion for intra-cohort inequality.

Financing such a policy reform with a consumption tax does not change the previous qualitative results. However, in this case, the required tax is lower than what I find when consumption is not adjusted. Indeed, the lower optimal tax to impose on business owners induces a higher consumption tax, which eventually hurts poor-income individuals. Moreover, the entrepreneurial human capital has small effect on the optimal rate when the planner is utilitarian. Its effect becomes stark only in the scenario in which the planner is willing to reduces the risky feature of entrepreneurship.

The optimality discussed in this paper is under the assumption of a linear tax on business income. Therefore, an important and interesting research extension would be to contrast the previous results in the context of non-linear tax schedules for both occupations.

Chapter 4

On the Corporate Tax Reform: Coordination and Trade-offs

4.1 Introduction

The U.S. corporate tax combined a relatively high statutory tax rate among OECD countries, and a tax base narrowed by loopholes and tax planning strategies. In addition, the double taxation faced by traditional C-corporations as opposed to pass-through entities - subject to one layer of taxation via individual tax code-, distorted the allocation of capital between business legal forms of organization. Moreover, the recent wave of corporate inversions has raised a concern of need of business tax reform for the Congress regardless of the political spectrum given the erosion of the tax base.[1] Even in the mainstream debate, proponents suggested that vigorous reforms must be taken to make the U.S. business environment more competitive and attractive.[2] The signing into law of the Tax

[1]Corporate inversion is a situation where a U.S. firm shifts its legal residence abroad to be deemed a foreign company for tax purposes, and therefore avoid paying the U.S. high tax rate. According to the Congressional Research Service, there were 23 inversions in 2012, compared to only three in total in 2010 and 2011. See The President's Framework for Business Tax Reform, 2016 for more details.

[2]The Economist in its article http://www.economist.com/news/briefing/21588379-mutation-way-companies-are-financed-and-managed-will-change-distribution describes how the rise of the "distorporation" or corporate inversions is hurting the U.S. economy. In their comments, Laurence Kotlikoff on http://www.nytimes.com/2014/01/06/opinion/abolish-the-corporate-income-tax.html?ref=opinion, and Gregory Mankiw on http://www.nytimes.com/2014/08/24/upshot/one-way-to-fix-the-corporate-tax-repeal-it.html suggest a pure repeal of corporate tax to reduce distortion imposed by the actual tax code to the allocation of capital among business types.

Cuts and Jobs Act (TCJA 2017) is a first step toward fulfilling that goal. For instance, the statutory corporate tax rate has been cut permanently to 21% down from 35% .

Despite the common ground on the idea of the business tax reform, an unanswered question still remains: *How to finance a corporate tax cut?* Inasmuch as a corporate tax cut or (simply) a repeal will generate a loss of revenues for the government that would have been used for social expenditures such as Medicare, Medicaid and others type of social transfers for needy families, a straightforward implementation might still induce unintended consequences. For instance, the Bush-era tax cuts with its extensions to 2010 and 2012 have put a *"fiscal cliff"* threat on the U.S. economy by the end of December 2012 provided that the U.S. was going technically over its debt ceiling.[3] With respect to the Trump's tax cuts, even a dynamic scoring embodying the positive feedback of growth still adds up $ 1.45 trillions to the current ballooned deficit of $ 20 trillions over the next decade.[4] Therefore, a responsible fiscal reform must add a revenue-neutral condition as a supplementary criterion. The revenue-neutral reform can be achieved by closing loopholes or tax exemptions specific to particular investments and raising other tax rates such as labor income tax, dividend tax, and capital gains tax.

This paper adopts the latter alternative and looks for the optimal mix of reform for designing a corporate tax cut. In doing so, not only can one derive a fiscal balanced multiplier determining the extent to which any given tax rises to offset a corporate tax cut, but also ranks different reforms by welfare. A corporate tax cut is a step toward an elimination of the double taxation faced by the C-corporations. Accordingly, if the entity level of taxation is removed then there is a level the playing field between C-corporations and pass-through entities (S-corporations, partnerships, and sole proprietorships) making the legal form of organization irrelevant for where a firm must allocate its capital in tax planning strategy lens. In this case, the tax burden is transferred to the shareholders, instead. As already pointed out by Harberger (1962, 1966), the tax differential between the corporate sector and non-corporate sector leads to a misallocation of the capital into the low return non-corporate sector. Furthermore, a high corporate statutory tax rate reduces a firm's investment at the margin given that the user cost of capital is high enough and return on investment low(Hall and Jorgenson, 1967; Auerbach et al., 1983; Cummins

[3]Estimates from the Congressional Budget Office indicate that the statutory debt limit was $16.394 trillions in 2012. If there were no fiscal cliff deal in Congress, this would have triggered cut in spendings and rise in taxes.

[4]See the estimates of the macroeconomics effects of the TCJA by the Joint Committee on Taxation JCT (2017) .

et al., 1994; Gravelle, 1994).

I address the previous question in an environment where a representative household and a representative corporate firm take dynamic decisions in presence of four types of tax rates, namely labor income tax, dividend tax, capital gains tax and corporate profit tax, all used to fund a fixed government outlay. I first set out the fiscal trade-offs, a revenue-neutral policymaker faces when he is willing to reduce corporate profit tax meanwhile keeping unchanged expenditures. Accordingly, I introduce a notion of a *balanced fiscal multiplier* to capture these potential trade-offs. This procedure then generates various possible reforms to implement, but only a parsimonious set of reforms is analyzed herein. A follow-up step is the determination of the optimality using a welfare-maximizing criterion to discriminate the best alternative. A first result reminiscent of the *new view* literature states that the long-run capital stock does not depend on dividend payments policy. That is, a mature firm prefers using retained earnings to finance its investment as opposed to redistributing dividend to shareholders such that accumulation decision and dividend payments policy are disconnected from one another.

Secondly, when labor income tax or dividend tax are individually used to make up the corporate profit tax cut, the balanced fiscal multiplier associated with labor income tax is smaller than that of dividend tax rate, and both are negative. Intuitively, since the household values leisure, its labor supply is elastic and it is capable of reducing labor supply while increasing leisure when labor income tax is raised. By contrast, given that dividend tax does not affect directly capital accumulation in the long run, the high tax burden is transferred to shareholders. However, I find that there is no trade-off when only capital gains tax is used to offset the cut. In fact, the multiplier is positive, suggesting that a corporate tax cut can be coupled with a cut in capital gain tax. This result is not innocuous to the mature corporate firm set-up used in this paper, which relies on retained earnings to finance its investment. Subsequently, the latter reform ends up being the one which is the welfare-maximizing scenario. The worst-case scenario is when dividend and capital gains are both used to finance the cut. In addition, when the transition is accounted for, the ranking of reforms changes for some reforms with respect to the certainty equivalent variation. Although the best and the worst scenario reforms still remain unchanged, the final objective of the planner shifts their ranking. Indeed, if the government is only preoccupied with revenue-neutral policy (the fiscal perspective), simultaneous hike in dividend and capital gains taxes is preferred to the double cut in corporate profit and capital gains taxes because surpluses are generated along the transition. In contrary, when the policymaker is guided by the welfare-maximizing criterion, then the double cut scenario is the best one.

This paper is related to the large corporate finance literature. The earlier development found in Harberger (1962) discusses the incidences of corporate tax in the capital allocation made by the firms between corporate and non-corporate sectors. Since it is not possible to address corporate profit tax without underscoring dividend and capital gains tax, a link between the current paper and dividend and capital gains tax discussion is relevant. Depending upon which strand of view is considered, dividend tax might impact or not the firm's investment and dividend payment decision. Following the *old view*, high dividend taxes increase the user cost of capital and reduce firm's investment, generating lower dividend paid out to shareholders (Poterba and Summers, 1983; Gravelle, 1994). The *new view*, however, disconnects firms investment decision from its dividend policy provided firm uses retained earnings to finance rather than equity (King, 1977; Auerbach, 1979; Bradford, 1981). Unlike the previous papers, the current analysis uses a general equilibrium setup and derives condition for fiscal neutrality when the corporate tax is cut.

Another strand of literature is that related to the assessment of the 2003 dividend with heterogeneous firms in incomplete markets. Results on investment are mixed to the extent that temporary low dividend and capital gains tax has surged higher dividend redistribution by firms (Chetty and Saez, 2005; Gourio and Miao, 2010), or has generated no significant effect on capital accumulation (Korinek and Stiglitz, 2009; Yagan, 2015). An investment reduction is even found in Anagnostopoulos et al. (2012) when dividend tax is cut in presence of household heterogeneity. The current paper is built upon a representative firm and household to understand the basic mechanisms. Finally, the closest paper is Anagnostopoulos et al. (2015) where double heterogeneity is used to assess the best mix of different taxes in financing a corporate tax reform. To some extent, heterogeneity has a small effect on fiscal neutrality. That is, the tax ranges of labor income tax, in particular, are close in the two models. However, once one acknowledges the welfare-maximizing criterion, heterogeneity generates diametrically opposed results.

The rest of the paper is organized as follows. Section 4.2 presents the model and derives the balanced budget multipliers, section 4.3 discusses the quantitative results of the benchmark economy, section 4.4 evaluates the transitional dynamics implications when counterfactual proposals (21% and 0%) are implemented, and section 4.5 concludes.

4.2 Model Economy

The economy is composed of a representative agent who each period consumes, chooses his mutual fund share and supplies labor to a representative firm. The firm hires labor and owns the capital. The presence of positive profit is essential to allow the firm to pay out dividend to shareholders, namely the household. It turns out, the household owns the firm since it stakes a claim on dividend payments. There is no shock in the model making all prices deterministic. Time is discrete and denoted by $0, 1, 2, \ldots$

4.2.1 *Household*

The agent chooses consumption C_t , labor supply N_t and next period mutual fund share S_t to maximize a non stochastic stream of standard time-additive utility as follows:

$$\max_{C_t, N_t, S_t} \sum_{t=0}^{\infty} \beta^t U(C_t, N_t) \tag{4.1}$$

$$C_t + P_t S_t = (1 - \tau_l) w_t N_t + \Big[(1 - \tau_d) D_t + P_t - \tau_g (P_t - P_{t-1}) \Big] S_{t-1} \tag{4.2}$$

$$N_t \in (0, 1), \quad S_t \geq 0 \tag{4.3}$$

where D_t is the total dividend amount generated by the firm, τ_l, τ_d, and τ_g are labor income tax, dividend tax, and capital gains tax, respectively. Capital gains are computed on an accrual basis.[5] Indeed, if stocks price P_t increases relatively to the previous period the household owes capital gains tax liability (τ_g) on the surplus value. On the contrary, a collapse in stock price relieves household from tax burden allowing it to deduct the capital loss. The utility function[6] $U(., .)$ is strictly concave in its both two arguments and satisfies Inada conditions, and β is the discount factor $\in (0, 1)$.

$$U(C_t, N_t) = log\left(C_t - \lambda \frac{N_t^{1+\sigma}}{1 + \sigma} \right), \tag{4.4}$$

[5] Although this is the standard approach in the literature some notable exceptions using realized basis approach are Gavin et al. (2007), and Dammon et al. (2001).

[6] This utility function is specified following Domeij and Heathcote (2004). It belongs to the Greenwood et al. (1988)'s class of function that aims at isolating wealth effect on labor supply decision. Then, only the wage and taxes matter to the household in its labor supply decision.

First order conditions for unconstrained agent (i.e. $S_t > 0$):

$$U_{ct} = \beta(1 + r_{t+1})U_{ct+1}, \tag{4.5}$$

$$U_{nt} = -(1 - \tau_l)w_t U_{ct}, \tag{4.6}$$

$$P_t U_{ct} = \beta((1 - \tau_d)D_{t+1} + P_{t+1} - \tau_g(P_{t+1} - P_t))U_{ct+1} \tag{4.7}$$

which can be re-written as :

$$U_{ct} = \beta(1 + r_{t+1})U_{ct+1}, \text{ where } 1 + r_{t+1} = \frac{(1 - \tau_d)D_{t+1} + P_{t+1} - \tau_g(P_{t+1} - P_t)}{P_t} \tag{4.8}$$

4.2.2 Firm

The representative firm has standard constant returns to scale technology and owns the capital making its problem dynamic too. Since the firm is allowed to pay out dividend and also that its value is related to the stocks prices, one needs to first derive its present discounted value. The production function is a Cobb-Douglas using capital K_t and labor L_t as inputs. Also, a total productivity factor A might account for the residual production, and it is assumed to be constant to the extent that aggregate shocks are precluded. The production function is then defined as:

$$Y_t \equiv F(K_t, L_t) = AK_t^{\alpha} L_t^{1-\alpha} \tag{4.9}$$

The dynamic nature of the firm's problem requires a financing constraint. In other words, once the firm has deducted operating cost composed by employees' compensation and capital depreciation, it gets the operating profit on which it pays a proportional corporate profit τ_c. However, before paying out the profit as dividend, the firm must decide how much to invest in the next period. Therefore, dividend (D_t) are the residual left after investment decision has been made, and financing decision can be set as:

$$D_t = (1 - \tau_c)(F(K_t, L_t) - w_t L_t - \delta K_t) - K_{t+1} + K_t \tag{4.10}$$

Using equation (4.8) and solving for P_t, one obtains

$$P_t = \frac{1}{1+\frac{r_{t+1}}{1-\tau_g}}\left[\frac{1-\tau_d}{1-\tau_g}D_{t+1} + P_{t+1}\right] \tag{4.11}$$

A forward iteration along with the non-bubble condition on prices [7] gives rise to

$$P_t = \sum_{j=1}^{\infty}\left(\prod_{i=1}^{j-1}\frac{1}{1+\frac{r_{t+1+i}}{1-\tau_g}}\right)\frac{1-\tau_d}{1-\tau_g}D_{t+j} \tag{4.12}$$

The objective of the firm is to maximize the market value of its shareholders. This value is composed of the dividend to be paid out and the current market price. Following Gourio and Miao (2010), I define the value as $V_t = \frac{1-\tau_d}{1-\tau_g}D_t + P_t$, which implies finally that

$$V_t = \sum_{j=0}^{\infty}\left(\prod_{i=1}^{j-1}\frac{1}{1+\frac{r_{t+1+i}}{1-\tau_g}}\right)\frac{1-\tau_d}{1-\tau_g}D_{t+j} \tag{4.13}$$

Therefore the firm's problem becomes

$$\max_{K_{t+1},L_t,D_t} V_t \qquad \text{s.t. } D_t = (1-\tau_c)(F(K_t,L_t) - w_tL_t - \delta K_t) - K_{t+1} + K_t \tag{4.14}$$

$$D_t \geq 0 \tag{4.15}$$

$$K_0 > 0 \tag{4.16}$$

Equation 4.15 states that firm cannot buyback or repurchase shares in a way of redistributing profit as dividend. Moreover, there is no possibility to issue new equity to finance investment. Therefore, in this setup, the net operating profit has to be split up between more redistribution (dividend payment) or more investment (retained earnings). One might then think of the structural debate over the firm's financing decision between *old* and *new view*.

[7]The non-bubble condition is to avoid future price to explode and leads the economy to an unstable path. This condition is given by $\lim_{J\to\infty}\prod_{n=1}^{J}\left(\frac{1}{1+\frac{r_{t+1+n}}{1-\tau_g}}\right)P_{t+1+n} = 0$.

First order conditions imply

$$w_t = F_L(K_t, L_t) \tag{4.17}$$

$$1 = \frac{1}{1 + \frac{r_{t+1}}{1-\tau_g}} \left[(1-\tau_c)(F_K(K_{t+1}, L_{t+1}) - \delta) + 1 \right] \tag{4.18}$$

$$P_t = \frac{1-\tau_d}{1-\tau_g} K_{t+1} \tag{4.19}$$

Equation 4.19 is not a direct first-order condition of the firm's problem,[8] but it is very important in explaining the dynamic of investment. K_{t+1} is the inside value of the firm whereas P_t is its outside value or market value set by investors. One can readily make the connection with Tobin's q theory where q will be defined as $\frac{1-\tau_d}{1-\tau_g}$. Then, If $q > 1$ the market values more the firm and investors are willing to invest in the firm and less when inequality reverses. The important aspect is how the tax mix between capital gains and dividend determines the price dynamics. Any wedge will create a financing distortion. Before the 2003 tax reform, qualified dividend were taxed at 30% and long-term capital gains at 24% implying a wedge in favor of capital gains and reducing the firm's market value. Then, the 2003 tax reform reduced both taxes down to 15% to eliminate the distortional wedge.[9]

4.2.3 *Government*

The economy is completed by a government sector which collects taxes on all types of transactions occurring in the economy to finance an exogenous and constant outlay G. Proportional taxes are levied on labor income, dividend income, capital gains, and corporate profit as well. The non-redistributional aspect of the government spending introduced in this model is simply intended to well capture the distortionary effect of taxes levied on firms and household whenever government is constrained to hold a balanced budget to its initial level. This assumption is key in determining fiscal trade-offs

[8] For its derivation, one needs to use equation 4.18 and makes use of the constant return to scale assumption to solve for capital stock K_{t+1}. A one-period forwarded version of equation 4.10 can then be plugged into the expression of K_{t+1} obtained in the first step. With this new equation, it is then possible to solve forwardly for capital stock and take at the limit the transversality condition on capital stock i.e. $\lim_{J\to\infty} \prod_{n=1}^{J} \left(\frac{1}{1+\frac{r_{t+1+n}}{1-\tau_g}} \right) K_{t+1+n} = 0$. Therefore, the result follows.

[9] Many papers in the literature have pointed out that those temporary tax cuts have mainly urged firms on redistributing more dividend instead of investing. (Chetty and Saez, 2005, 2006) and Yagan (2015) for recent survey.

further below. Then, the invariant spending is given by:

$$G = \tau_d D_t + \tau_l w_t L_t + \tau_g (P_t - P_{t-1}) + \tau_c [F(K_t, L_t) - w_t L_t - \delta K_t] \tag{4.20}$$

4.2.4 Equilibrium and Qualitative results

Definition 1 (Competitive equilibrium). *A competitive equilibrium consists of sequences* $\{C_t, N_t\}_{t=0}^{\infty}$, $\{K_{t+1}, L_t, D_t\}_{t=0}^{\infty}$, *prices* $\{r_t, w_t, P_t\}_{t=0}^{\infty}$, *and government expenditure and tax plan* $\{G, \tau_{lt}, \tau_{dt}, \tau_{gt}, \tau_{ct}\}_{t=0}^{\infty}$ *such that:*

1. *Given prices* $\{r_t, w_t, P_t\}_{t=0}^{\infty}$ *and dividend* $\{D_t\}_{t=0}^{\infty}$, $\{C_t, N_t\}_{t=0}^{\infty}$, *solves household's problem in (4.1),*
2. $\{K_{t+1}, L_t, D_t\}_{t=0}^{\infty}$ *solves firm's problem in (4.13) given prices* $\{r_t, w_t, P_t\}_{t=0}^{\infty}$,
3. $\{G, \tau_{lt}, \tau_{dt}, \tau_{gt}, \tau_{ct}\}_{t=0}^{\infty}$ *balances government's budget according to (4.20),*
4. *and markets clear: labor:* $N_t = L_t$, *capital:* $S_t = 1$, *goods:* $C_t + K_{t+1} + G = Y_t + (1 - \delta) K_t$

Accordingly, the corresponding steady state is defined as follows:

$$1 = \beta(1 + r) \tag{4.21}$$

$$U_n = -(1 - \tau_l) w U_c, \tag{4.22}$$

$$w = (1 - \alpha) A K^{\alpha} L^{-\alpha} \tag{4.23}$$

$$r = (1 - \tau_g)(1 - \tau_c)(\alpha A K^{\alpha - 1} L^{1 - \alpha} - \delta) \tag{4.24}$$

$$P = \frac{1 - \tau_d}{1 - \tau_g} K \tag{4.25}$$

$$D = (1 - \tau_c)(F(K, L) - wL - \delta K) \tag{4.26}$$

$$G = \tau_d D + \tau_l w L + \tau_c (A K^{\alpha} L^{1 - \alpha} - wL - \delta K) \tag{4.27}$$

$$C + G = A K^{\alpha} L^{1 - \alpha} - \delta K \tag{4.28}$$

Using (4.4),(4.22) and (4.23) implies steady-state labor as

$$L = \left[\lambda^{-1} (1 - \tau_l)(1 - \alpha) A K^{\alpha} \right]^{\frac{1}{\alpha + \sigma}} \tag{4.29}$$

Plugging (4.21) and (4.29) into (4.24) leads to the steady-state capital stock

$$K = \left[\frac{1-\beta}{\beta\alpha A(1-\tau_g)(1-\tau_c)B(\tau_l)} + \frac{\delta}{\alpha A \cdot B(\tau_l)} \right]^{\frac{\alpha+\sigma}{\sigma(\alpha-1)}} \tag{4.30}$$

where $B(\tau_l) = \left(\lambda^{-1}(1-\tau_l)(1-\alpha)A \right)^{\frac{1-\alpha}{\alpha+\sigma}}$

We can then define this stock as an implicit function of labor income, capital gain and corporate's profit tax rates: $K \equiv K(\tau_l, \tau_g, \tau_c)$

Proposition 1. *: The long-run capital stock is independent of dividend tax rate τ_d.*

The intuition behind this result is simply that, the representative firm can use retained earnings to finance investment instead of using dividend even in presence of dividend tax cut. This regime will not change provided it is only one type of firm that is in consideration. This result is reminiscent of the *new view* or *tax capitalization view* literature on dividend tax effect on investment (King, 1977; Auerbach, 1979; Auerbach and Hassett, 2003). Developing a firm life-cycle model wherein cash holding is important to determine the firm's dividend payment decision, Korinek and Stiglitz (2009) conclude that a permanent dividend tax cut does not affect aggregate investment since macroeconomics dynamics are dominated by mature firms for which dividend tax is not distortionary. However, Gourio and Miao (2010) using Compustat data pointed out that approximately 10% of firms issue equity and once heterogeneity is included dividend tax have a steady-state effect on the firms' capital stock, hence on investment. In general, those firms are highly productive but equity constrained.

One goal of the current analysis is to stress tax reform trade-offs and coordination policymaker might be able to implement given the four types of tax he has control over in the underlying model. The only condition imposed on the policymaker is to always run a balanced budget.

Definition 2 (Balanced fiscal reform multiplier)**.** *: Given a tax cut, a balanced budget multiplier is a factor by which one (or a combination) of other tax rates must be raised to make up the initial decrease while maintaining the same expenditure for the government.*

Using implicit function notation, one can express $D \equiv D(\tau_c, \tau_l, K(\tau_g, \tau_c))$, $w \equiv K(\tau_l, \tau_g, \tau_c)$ and by (4.2.4) firm's profit is $\frac{1}{1-\tau_c} D(\tau_c, \tau_l, K(\tau_l, \tau_g, \tau_c))$. Therefore, the steady-state government budget is as follows

$$G = \tau_d D(\tau_c, \tau_l, K^\nu(\tau_l, \tau_g, \tau_c)) + (1-\alpha)\tau_l B(\tau_l) K^\nu(\tau_l, \tau_g, \tau_c) + \frac{\tau_c}{1-\tau_c} D(\tau_c, \tau_l, K^\nu(\tau_l, \tau_g, \tau_c)) \tag{4.31}$$

Proposition 2 (Fiscal trade-off)**.** *: If the government is subject to a long-run balanced budget, then any trade-off is given by the following balanced fiscal reform multiplier:*

$$d\tau_c = -\Phi^{-1}\left[D \cdot d\tau_d + \Psi \cdot d\tau_l + \Omega \cdot d\tau_g\right], \textit{ where}$$

$$\Phi = \left(\frac{\tau_d}{\tau_c} + \frac{1}{1-\tau_c}\right)\left(e_{d/\tau_c} + \nu K^{\nu-1} e_{d/k} e_{k/\tau_c}\right) D + \frac{\nu(1-\alpha)\tau_l B(\tau_l) K^\nu}{\tau_c} e_{k/\tau_c} + \frac{D}{(1-\tau_c)^2}$$

$$\Psi = \left(\tau_d + \frac{\tau_c}{1-\tau_c}\right)\left(e_{d/\tau_l} + \nu K^{\nu-1} e_{d/k} e_{k/\tau_l}\right)\frac{D}{\tau_l} + (1-\alpha)(1+\nu e_{k/\tau_l}) B(\tau_l) K^\nu + (1-\alpha)\tau_l K^\nu \frac{dB}{d\tau_l}$$

$$\Omega = \frac{\nu K^{\nu-1} e_{k/\tau_g}}{\tau_g}\left[\left(\tau_d + \frac{\tau_c}{1-\tau_c}\right) D \cdot e_{d/k} + (1-\alpha)\tau_l B(\tau_l) K\right],$$

$$B(\tau_l) = \left(\lambda^{-1}(1-\tau_l)(1-\alpha)A\right)^{\frac{1-\alpha}{\alpha+\sigma}}$$

K and D are steady-state capital stock and dividend, respectively.

$e_{x/\tau}$ the elasticity of variable x with respect to a given tax rate τ, and $\nu = \frac{\alpha(\sigma+1)}{\alpha+\sigma}$

Proof. See Appendix 4.9.1. □

Proposition 2 states that the implementation of a tax reform has trade-offs government must face. In other words, with the constraint to running a balanced budget, a corporate tax cut must be followed up by an increase in other tax rates.[10] For instance, if corporate tax is cut by 1 percentage point, labor income tax has to increase by $-\Phi\Psi^{-1}$ percentage point, else being equal, and this is in fact what is called *balanced fiscal multiplier* in this paper. One should note that Proposition 2 is more general than the purpose in this model. The main purpose of the present analysis is to discuss the potential trade-offs when a revenue-neutral government would like to cut corporate tax. Instead, other questions related to cut in labor income tax, dividend tax, and capital gains tax could have also a likewise treatment using the above proposition. Moreover, the characterization of the

[10] In Appendix 4.9.2, I discuss the case where revenue-neutrality is not imposed.

multiplier generates elasticities one needs to provide numerical values..[11] For the present simplistic model, one could use the steady-state values to compute the elasticities point-estimates and then use them to calculate the multiplier for any kind of reform. One might consider these multipliers as lower bound provided that the model does not take into account any type of heterogeneity.

The signs of the elasticities in presence are quite straightforward. By equation(4.30), the elasticity of capital with respect to corporate tax and capital gains tax rates are negative ($e_{k/\tau_c} < 0, e_{k/\tau_g} < 0$). The intuition is that corporate tax rate reduces the firm's profit which at the end, is paid out to the shareholder as dividend leading to a decrease in household's savings, hence a reduction in investment too. Following this argument, one sees readily that the corporate tax offsets dividend payment as well ($e_{d/\tau_c} < 0$). Capital gains tax also affects negatively investment because it raises the user cost of capital, and as stated in equation (4.30), the steady-state capital stock is independent of dividend tax rate, the firm can then use retained earnings to invest. This makes capital gains tax a distortional one. The last elasticity, namely the elasticity of dividend to capital (or investment) is subject to dispute in the literature given that one analyzes either through the lens of the *old view* or the *new view* ($e_{d/k} \lesseqqgtr 0$). The *old view* claims that the dividend tax is harmful to investment because it increases the user cost of capital and firms use at least two-thirds of their asset to finance their investment, and therefore the lower the investment the lower the dividend paid out ($e_{d/k} > 0$) (Poterba and Summers, 1983; Gravelle, 1994). On the other hand, the *new view*'s proponents argue that, since a firm uses mostly retained earnings to increase its production capacity, its dividend policy is disconnected from the investment decision or at least dividend payments are reduced when there are prospective investments.[12]

Definition 3 (Basic Reforms)**.** *: A reform is a coordination of tax changes government could implement given its constraint. With double taxation principle, the following reforms are the trade-offs related to a corporate tax cut ($d\tau_c < 0$).*

(i) Reform 1 : corporate tax cut is financed by a rise in labor income tax ($d\tau_c < 0, d\tau_l > 0$, and $d\tau_d = d\tau_g = 0$);

---

[11]There are no standard value ranges for these elasticities in the literature. Therefore, to be able to give values range to the multipliers I take a stand on their possible values. I then used the steady-state values of all variable needed to compute those elasticities point-estimates. In addition, when computing transitional dynamics I assume that those elasticities are constant.

[12]However, if the dividend tax cut is temporary even the *new view* predicts a rise in dividend payment. (Chetty and Saez, 2005; Korinek and Stiglitz, 2009).

(ii) *Reform 2: corporate tax cut is financed by an increase in dividend tax (*$d\tau_c < 0, d\tau_d > 0$*, and* $d\tau_l = d\tau_g = 0$*);*

(iii) *Reform 3: corporate tax cut is financed by an hike in capital gains taxes (*$d\tau_c < 0, d\tau_g > 0$*, and* $d\tau_l = d\tau_d = 0$*);*

(iv) *Reform 4: corporate tax cut is financed by a mix in labor income and dividend tax (*$d\tau_c < 0, d\tau_l = d\tau_d > 0$ *and* $d\tau_g = 0$*).*

(v) *Reform 5: corporate tax cut is offset by a combination in labor income and capital gains taxes (*$d\tau_c < 0, d\tau_l = d\tau_g > 0$ *and* $d\tau_d = 0$*).*

(vi) *Reform 6: corporate tax cut is made up using dividend and capital gains taxes (*$d\tau_c < 0, d\tau_d = d\tau_g > 0$ *and* $d\tau_l = 0$*).*

(vii) *Reform 7: corporate tax cut is financed by a mix of all three taxes (*$d\tau_c < 0, d\tau_l = d\tau_d = d\tau_d > 0$*).*

The above reforms are not exhaustive but are retained for sake of clarity and defined are basic. This terminology simply implies that in each of these reforms, the concerned tax rates will be subject to the same multiplier once the corporate tax is cut. For instance, reform 1 aims at providing insight into the negative effect borne by the household through its labor supply. Reform 2 implements a distortion on the firm investment funding opportunities by shareholders net return, given that a low net return disincentivizes savings. In reform 3, one looks for distortions brought into the economy when capital gains tax is raised, and from the steady-state capital stock in (4.30), one can see the direct impact of capital gains tax on investment. The last reform (7) uses an identical hike in the three tax available to make up the cut. However, reforms 4, 5 and 6 just choose a special case where the two taxes in each combination are increased equally. Further in section 4.3.2, more analysis will explicitly show the different mix one is able to deduct from these last three reforms.

Lemma 1 (Implementability)**.** *: If* $\tau \in (0, 1)$*, then any balanced fiscal reform multiplier is implementable with respect to:*

(i) ***Reform 1 :*** $d\tau_c = -\Phi^{-1}\Psi d\tau_l$ *iff* $\Phi^{-1}\Psi > 0$*, and* $d\tau_c > (\tau_l^0 - 1)\Psi\Phi^{-1}$*;*

(ii) ***Reform 2 :*** $d\tau_c = -\Phi^{-1}Dd\tau_d$ *iff* $\Phi^{-1} > 0$*, and* $d\tau_c > (\tau_d^0 - 1)D\Phi^{-1}$*;*

(iii) ***Reform 3 :*** $d\tau_c = -\Phi^{-1}\Omega d\tau_g$ *iff* $\Phi^{-1}\Omega > 0$, *and* $d\tau_c > (\tau_g^0 - 1)\Omega\Phi^{-1}$;

(iv) ***Reform 4 :*** $d\tau_c = -\Phi^{-1}(\Psi + D)d\tau_l$ *iff* $\Phi^{-1}(\Psi + D) > 0$, *and* $d\tau_c > (\tau_l^0 - 1)(\Psi + D)\Phi^{-1}$,

(v) ***Reform 5 :*** $d\tau_c = -\Phi^{-1}(\Psi + \Omega)d\tau_l$ *iff* $(\Psi + \Omega)\Phi^{-1} > 0$, *and* $d\tau_c > (\tau_l^0 - 1)(\Psi + \Omega)\Phi^{-1}$;

(vi) ***Reform 6 :*** $d\tau_c = -\Phi^{-1}(D + \Omega)d\tau_d$ *iff* $(D + \Omega)\Phi^{-1} > 0$, *and* $d\tau_c > (\tau_d^0 - 1)(D + \Omega)\Phi^{-1}$;

(vii) ***Reform 7 :*** $d\tau_c = -\Phi^{-1}(D + \Psi + \Omega)d\tau_l$ *iff* $(D + \Psi + \Omega)\Phi^{-1} > 0$, *and* $d\tau_c > (\tau_l^0 - 1)(D + \Psi + \Omega)\Phi^{-1}$; *where* τ_l^0, τ_d^0, *and* τ_g^0 *are the initial tax rates.*

Otherwise, there is no trade-off and corporate tax cut can be coordinated with corresponding cut in other tax rates.

Proof. See Appendix 4.9.3. □

The above conditions state that under the trade-off assumption to balance the government's budget and the fact that any tax rate must lie in $(0, 1)$, a tax cut in corporate tax must be compensated by a factor-equivalent rise in the appropriate tax rates. Interestingly, when this implementability condition does not hold the tax policy and its coordination change. Specifically, in this scenario, there is no longer compromise between concurrent taxes but rather a double tax cut. Therefore, the government can decrease/subsidize the other tax rates while decreasing the corporate profit tax and maintaining a revenue-neutral policy.

4.3 Quantitative analysis

4.3.1 Calibration

In this section, I provide numerical values range to the different multipliers developed in the previous section. To do so, I use standard parameters value from the literature relative to the US economy.

Preferences: Following Gourio and Miao (2010), I choose a discount rate β at 0.971 to deliver an annual mutual fund after-tax interest rate r of 3% using equation (4.21). The inverse of the curvature of hours worked, $1/\sigma$ is the Frisch elasticity of labor. Choosing a value $\sigma = 1.7$ yields a Frisch elasticity of 0.6. This is somewhat higher than micro levels estimates which are around 0.25 (Blundell and MaCurdy, 1999) but discussing Frisch elasticity thorough micro and macro estimates Chetty et al. (2011) recommend higher values around 0.75 in representative macro models.[13] Finally, the leisure weight in the utility function is chosen at 4.9062 to deliver an average hour worked of one-third at equilibrium.

Technology: For the production function, the capital income share α is set to 0.33. The depreciation rate δ is calibrated at 7.6% to account for a steady-state aggregate investment-output ratio of 20% as in Restuccia and Rogerson (2008). The implied capital-output ratio is this economy is then 2.5 which is in the range of standard values in macro literature. Productivity A is normalized to one.

Government: The average effective labor income tax is set to 28% and can be found in Mendoza et al. (1994), dividend tax and capital gains tax are 20% and 20%, respectively and are consistent with the U.S. 2013 tax law. The top statutory corporate tax rate is fixed to 33% in order to determine a government spending-output ratio of 25% in equilibrium.

A summary of the benchmark economy is given in table 4.1. The first block of parameters are directly taken from the literature and this does not necessitate a comparison with the data counterparts. On the other hand, the second block of the table shows the parameters calibrated jointly to match moment targets in the data. The relative simple structure of the model allows a close match of the data.

4.3.2 Benchmark Economy

Fiscal multipliers

Given the benchmark parameters, one can figure the steady-state point-estimates of the previous elasticities and multipliers as well.

From table 4.2, the signs of the different elasticities are consistent with the theory. Particularly, the elasticity of dividend with respect to capital is negative ($e_{d/k} < 0$) and then provides a compelling support for the *new view*'s argument. The baseline calibration is also consistent with the implementability conditions imposed by lemma 1,[14] except only for reform 3 wherein corporate tax cut is entirely financed by a cut (or even a

[13] I discuss in Appendix 4.9.4 the sensitivity of the elasticities and the multipliers when the Frisch elasticity of labor is modified, else being equal.

[14] Table 4.3 does not allow to clearly check the second part of the implementability conditions. In the numerical simulation those conditions are checked out, though.

Table 4.1: Benchmark calibration

Definition	Parameters	Value	Moment target/source	Model
Discount factor	β	0.971	interest rate $r = 3\%$	
Capital share	α	0.33	U.S. data	
Inv. Frisch elas.	σ	1.70	Chetty et al. (2011)	
Technology parameter	A	1.00	Normalization	
Labor income tax	τ_l	0.28	Mendoza et al. (1994)	
dividend tax	τ_d	0.20	U.S. 2013 tax law	
Capital gains tax	τ_g	0.20	U.S. 2013 tax law	
joint calibration				
Depreciation	δ	0.08	$I/Y = 0.20$	$I/Y = 0.198$
Labor disutility weight	λ	4.91	$N = 1/3$	$N = 0.332$
Corporate tax	τ_c	0.33	$G/Y = 0.25$	$G/Y = 0.252$

subsidy) in capital gains tax. Then the implementability condition is a way of setting out a range of tax rates whereby the government could define its tax policy without running a deficit.[15]

Table 4.2: Elasticities and multipliers

Definition	Variables	Value
elasticity of dividend w.r.t. corporate tax	$e_{d/c}$	-0.3726
elasticity of dividend w.r.t. capital	$e_{d/k}$	-0.3220
elasticity of dividend w.r.t lab. tax	$e_{d/l}$	-0.2288
elasticity of capital w.r.t corporate tax	$e_{k/c}$	-0.3726
elasticity of capital w.r.t capital gains tax	$e_{k/g}$	-0.1891
elasticity of capital w.r.t lab. tax	$e_{k/l}$	-0.2288
steady-state multiplier Φ	Φ	0.0270
steady-state multiplier Ψ	Ψ	0.2462
steady-state multiplier Ω	Ω	-0.0369

Note: w.r.t stands for with respect to.

[15] The characterization of the balanced budget fiscal multiplier is not treated as a primal Ramsey problem provided that the present question is to find a tax range in which planner could discretionarily pick up the welfare-maximizing corresponding tax rate. However in the numerical exercise, after solving for tax range, an attempt is made to provide welfare-maximizing analysis. The question in order is: *Given a corporate tax cut, what reform delivers the highest consumption equivalent variation?*

Proposition 2 puts forward the change of the corporate tax rate given a modification in the other tax rates. One can re-write the previous equality such that a variation in a specific tax rate is deduced by a cut in corporate tax rate. To see this, let's consider the case of a decrease in corporate tax rate($d\tau_c < 0$) balanced by a labor income tax increase. Since the question is how much to raise the labor income tax rate, the equality becomes $d\tau_l = -\Phi\Psi^{-1}d\tau_c$ using the expression in proposition 2. Here, the multiplier for the labor income tax is $-\Phi\Psi^{-1}$. Accordingly, the higher the absolute value of the multiplier the higher the increase in the labor income needed to compensate the cut in the corporate tax rate. More generally, I report in table 4.3 the value (not absolute) of the multipliers corresponding to each of the seven basic reforms. Given a one percentage point decrease in corporate tax rate, there is approximately a 0.10 percentage point tax increase in reforms $1, 4, 5$ and 7. This rise is close to the one obtained only from reform 1 where labor income tax is used to offset a cut in the corporate tax. The intuition is as follows, labor income tax is the common factor relating reforms $1, 4, 5$ and 7, therefore whenever it is possible the tax burden is shifted away from dividend and/or capital gains toward labor.[16] However, this situation potentially might hurt the economy via lower labor supply, but less distortion on the firm side could help alleviate the negative impact.

Reforms 2 and 6 present higher multipliers in absolute value as opposed to that of the other reforms. Also, the labor income tax is not associated with these two reforms. Therefore, the high values are mainly driven by the dividend income tax. Indeed, provided that dividend tax does not distort directly the steady-state capital stock, the tax burden is now transferred to dividend income. Finally, I find that the multiplier in reform 3 is positive. This means that a one percentage point cut in corporate tax rate is followed by a 0.73 percentage decrease in the capital gains tax rate. In this situation, there is no longer a trade-off. The intuition here is that the firm uses retained earnings to finance its future investment, therefore a tax burden on capital gains will impact significantly the aggregates variables of the economy.

There exist various experiments one could draw from the benchmark, but I make an attempt to summarize some results following the seven aforementioned reforms.

[16] Domeij and Heathcote (2004) show in a heterogeneous environment that when capital tax cut is transferred to labor income, poor agents suffer the most and leads to a welfare-reducing scenario. Although the current model is set in a representative agent perspective, the labor financing scenario is not the first best alternative, either.

Table 4.3: Multipliers

Reform	Definition	Value (in percentage point)
reform 1	labor income tax	-0.11
reform 2	dividend income tax	-0.55
reform 3	capital gains tax	0.73
reform 4	labor and dividend tax	-0.09
reform 5	labor and capital gains tax	-0.13
reform 6	dividend and capital gains tax	-2.20
reform 7	all 3 taxes	-0.10

Note: Each multiplier is computed using the fiscal multiplier in proposition 2, the corresponding definition of a given reform and the steady-state elasticities point estimates reported in table 4.2.

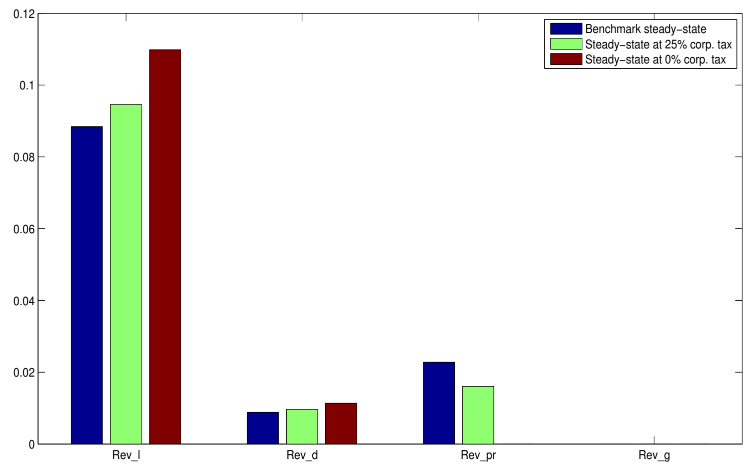
Tax change and trade-offs

The main theoretical result stated in proposition 2 only gives the extent to which taxes react from each another when there is an exogenous change. This section aims at providing numerical values to the concerned taxes once a tax change is implemented, namely a corporate tax cut. Before getting into tax changes, one might like to have an overview behind the assumption of trade-off. This is done in figure 4.1 where tax revenues are highlighted and labor income tax used to make up the corporate tax cut (reform 1).

Blue bars represent the steady-state of the benchmark economy where corporate tax is 33% and it is already clear that labor income contributes the most to funding government spending. In fact, labor income tax revenue, profit tax revenue, and dividend income tax revenue are 74%, 19% and 7% of steady-state government outlay. When corporate tax is moved to 25% (an OECD-average corporate's profit tax rate), green bars clearly demonstrate the trade-off at work since green bars are now higher than the blue ones for mainly labor income whilst tax revenue stemming from corporations decreases. This pattern is pronounced when the corporate tax is simply eliminated, namely when there is no longer double taxation. Tax revenues collected from dividend stay barely unchanged given that only labor tax has been modified. However, the small variation observed is due to the general equilibrium effect that sustains higher capital stock, hence higher profit, and more dividend redistribution. It is worthy to note that, no tax income has not been collected from capital gains because at the steady-state there are no gains since stock prices are constant.

In table 4.4 are reported the numerical values when one-dimensional reforms are im-

Figure 4.1: Overview of tax revenues when reform 1 is implemented



Note: the x-axis describes the sources of tax revenue for the government. There are four in the present model: labor income tax revenue (Rev_l), dividend income tax revenue (Rev_d), corporate's profit tax revenue (Rev_{pr}) and capital gains tax revenue (Rev_g).

plemented (i.e. reforms 1, 2, and 3). Labor income tax varies from 28% to 32%, dividend income tax from 20% to 38.5%, and as stated above via implementability condition reform 3 provides tax cut and even tax subsidizing scenario which allows the capital gains tax to move down from 20% to -4%.[17] This relies on the assumption that the representative corporate firm uses more retaining earnings in lieu of dividend for investors. Moreover, the dividend tax schedule has a higher growth rate than that of labor income tax. The intuition goes as follows. The household labor supply is elastic and will react negatively to a large increase in labor income tax. However, to the extent that in the firm's side dividend are determined by the net profit which is directly affected by the corporate tax, then the firm is willing to pay out more dividend during a corporate tax cut while letting the household bear the reform cost via a high level of dividend tax imposed to shareholders. In this type of reform, the balanced fiscal multiplier is predicted at 18.4% once double taxation is eliminated which is higher than the 4% for labor income

[17] Form lemma 1 the following condition must hold for reform 3: $d\tau_c = -\Phi^{-1}\Omega d\tau_g$ iff $\Phi^{-1}\Omega > 0$, and $d\tau_c > (\tau_g^0 - 1)\Omega\Phi^{-1}$. Using benchmark calibration, $\Phi^{-1}\Omega = -1.37 < 0$ contradicting the first part of the previous condition. One could have first checked the second part, then in this case if the corporate tax cut is, say $d\tau_c = -5\%$ with $(\tau_g^0 - 1)\Omega\Phi^{-1} = (.2 - 1) * (-1.37)^{-1} = .58$, again a contraction is reached. Since at least one sub-condition does not hold, implementability condition implying trade-off falls and a cut can go along with another cut.

tax. Still, one must bear in mind that dividend tax does impact capital but indirectly through household's saving decision and capital price stock.[18]

Columns of table 4.5 show the level of tax rates when there is a mix of two or three taxes change following a corporate tax cut (reform 4 to reform 7). Tax levels are almost in line with figures in table 4.4, but a sparkling pattern is displayed where both dividend and capital gains tax are used to offset the cut. Taxes range from 20% to 97%. This result was predictable since a high value of balanced fiscal multiplier has been found in table 4.3 for reform 6. Accordingly, a revenue-neutral reform is costly for the household provided that it supports both tax rise through a reduction in savings, and in general equilibrium, the steady-state aggregate capital decreases since there is a negative relationship between capital stock and long-term capital gains tax.

The exploratory aspect of the present analysis makes it somewhat difficult to compare the obtained results with others studies. The main reason is that the current literature is most focused on dividend and capital gains tax cut rather than corporate tax or double taxation. However, Anagnostopoulos et al. (2015) perform counterfactuals by cutting or completely eliminating the double taxation burden on corporations in a heterogeneous environment. They only carry out reforms 1, 2 and 6. To some extent, the tax ranges found here are close to theirs, above all in the particular case of labor income tax. In fact, in reform 1 when only labor tax is implemented their labor income tax ranges from 28% to 34.7% whereas the current model predicts tax between 28% to 31.71%. The inelasticity of labor supply in Anagnostopoulos et al. (2015) might be the channel through which more tax burden is transferred to agents in the economy. If dividend tax is used to make up the corporate tax decrease, the discrepancy is large between the two models: 20% to 54.2% as opposed to 20% to 38.51% in this model. Instead, when dividend and capital gains taxes are both used to clear the cut they provide a range from 20% to 54.7% whereas that found here is 20% to 96.91%. The heterogeneity in the firm side is one key element explaining this fact since firms have different productivity and react differently to a tax cut, inducing therefore, a capital reallocation effect in the economy which is not feasible

[18] As is highlighted in subsection 4.2.2 with equation 4.19, the logic of Tobin's q theory is at work and helps explain how any difference between the inside value of the firm and the market value (perceived by investors) determines the willingness of households to save and invest in the firm. The complete market structure in this economy precludes savings for precautionary motive as opposed to that in a Aiyagari-type model. A comprehensive explanation of the investment dynamics cannot be drawn out of the current model since there is only a mature representative firm making all investment decision. See Gourio and Miao (2010), Anagnostopoulos et al. (2015) for a discussion in heterogenous firms environment.

in the current environment.[19]

Table 4.4: Level change in tax rates (Reforms 1 to 3)

Corp. tax	Labor (Ref.1)	dividend (Ref. 2)	Cap. gains (Ref. 3)
.33	.2800	.2000	.2000
.32	.2821	.2108	.1865
.30	.2843	.2217	.1713
.28	.2865	.2326	.1569
.26	.2887	.2435	.1426
.24	.2909	.2544	.1282
.22	.2931	.2653	.1139
.20	.2952	.2762	.0995
.18	.2974	.2871	.0852
.16	.2996	.2980	.0708
.14	.3018	.3089	.0565
.12	.3040	.3198	.0421
.10	.3062	.3307	.0278
.08	.3083	.3416	.0134
.06	.3105	.3525	-.0008
.04	.3127	.3633	-0152
.02	.3149	.3729	-.0295
00	.3171	.3851	-.0439

Note: This table reports numerical values of the four taxes according to one dimensional basic reforms. Each column is the counterpart of the concerned tax to a change in corporate tax rate, ceteris paribus.

[19]The current model does not seek to forcefully demonstrate equivalence between representative agent setup and heterogeneous model when balanced budget reform is implemented. In turn, one takeaway form here is the similar pattern found in both models once corporate tax is cut regardless the reform implemented. As is discussed later on, heterogeneity has in some extent small effect on budget perspective, but is very relevant when welfare analysis is accounted for. The best welfare-maximizing scenario in Anagnostopoulos et al. (2015) is reversed to be the worst-case scenario in this model (reform 6). Firm heterogeneity is a main channel sustaining this result.

Table 4.5: Level change in tax rates (Reforms 4 to 7)

Corp. tax	Lab.& Div. (Ref. 4)		Lab.& Gains (Ref. 5)		Gains &Div.(Ref. 6)	All (Ref. 7)	
	τ_l	τ_d	τ_l	τ_g	$\tau_d = \tau_g$	τ_l	$\tau_d = \tau_g$
.33	.2800	.2000	.2000	.2000	.2000	.2800	.2000
.32	.2818	.2018	.2826	.2026	.2452	.2821	.2021
.30	.2836	.2036	.2852	.2052	.2905	.2842	.2042
.28	.2855	.2055	.2877	.2077	.3357	.2862	.2062
.24	.2891	.2091	.2929	.2129	.4262	.2904	.2104
.20	.2927	.2127	.2980	.2180	.5167	.2946	.2146
.16	.2964	.2164	.3032	.2232	.6072	.2987	.2187
.12	.3000	.2200	.3083	.2283	.6976	.3029	.2229
.08	.3036	.2236	.3135	.2335	.7881	.3071	.2271
.04	.3073	.2273	.3186	.2386	.8786	.3112	.2312
00	.3109	.2309	.3238	.2438	.9691	.3144	.2344

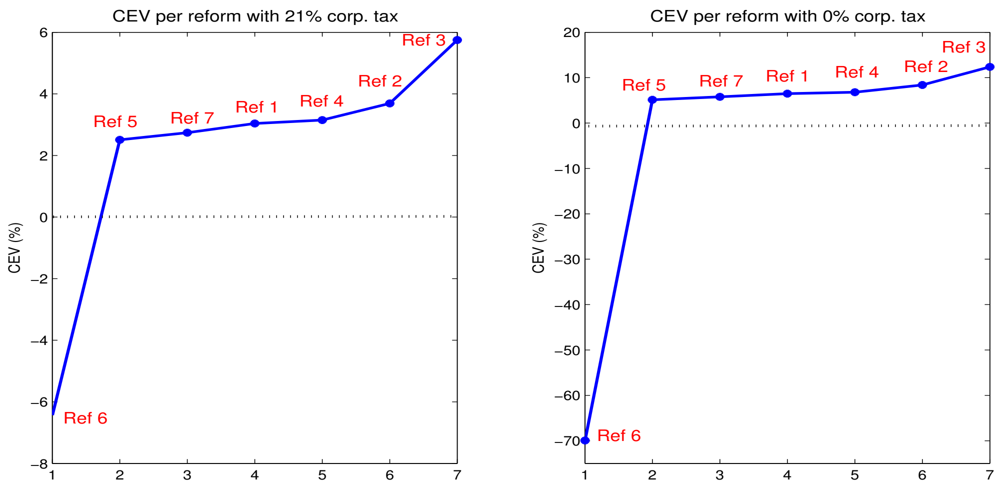
Note: This table reports numerical values of the four taxes according to basic reforms. It assumes that in each reform, the concerned taxes face the same multiplier.

Optimality

According to the result in proposition 2, there exists numerous combination of reforms the government can implement. Seven cases are available when only basic reforms are retained.[20] However, *what is the best reform?* The approach here is not a standard Ramsey primal problem in which the planner chooses an optimal tax level for optimizing agents. Instead, following the recent debates on the effect of a corporate tax cut before and after the passing of the Tax Cuts and Jobs Acts in the U.S. Congress, I implement two tax cut scenarios, rank reforms by their consumption equivalent variation (CEV) and choose the highest. The first scenario is in accordance with the new tax bill to cut the corporate tax to 21% down from 33%. The last one is to mirror the view of proponents of the repeal, i.e. a corporate tax rate of 0%.

[20] *"basic reform"* means that aside from reform in which one tax rate is used to offset the cut (reform 1, 2 and 3), the fiscal multiplier needed is the same for all taxes whenever there is a mix as such in reforms 4, 5, 6 and 7. One should keep in mind that in the latter reforms the multiplier is the same but the tax levels are not (see table 4.5 for more details). Once the required multiplier is not the same in any given tax mix, then there exists a continuum of combinations of tax proposal.

Figure 4.2: Optimal reform



Note: Each blue line in the panel represents the consumption equivalent variation (CEV) needed to compensate the household between the two steady-states in the two tax experiments. The circles are the CEV values and the reform references in red indicate the reforms that generated those values. The horizontal axis only helps construct the graphs and does not have any meaning per se.

Figure 4.2 shows the ranking of reforms by CEV in each scenario for the long run. Transitional dynamics implications are discussed in the next section. While the welfare gain derived from the repeal is higher than that in the 21%-scenario, the ranking is the same among reforms. Not surprisingly, reform 3 wherein the corporate cut is mirrored by a 15.69% capital gains tax in the 21%-scenario, and by a subsidy of 4.39% in the 0%-scenario comes first since both cuts spur investment, capital stock and consumption in the long-run. Although the model predicts this reforms as the best one, it might be tough to implement to the extent that criticisms may come from either political arena or academics. By historical standard, capital gains tax rates have been lower than regular income tax and the Internal Revenue Service (IRS) computes capital gains tax liabilities on a realized basis in lieu of accrual basis. Therefore, many wealthy individuals hold on to their assets until death before passing them on to their heirs. As a result, less than 1% of those wealthiest families pay capital gains tax because of lock-in effect.[21] In

[21] This effect arises because individuals avoid paying tax on their assets by never selling them until death and are then transferred as inheritance. A little part of those assets will be taxed if over a $11 millions dollar cap for married couples. This is also known as " death tax". For corporations, capital gains tax triggers accumulation of retained earnings over dividend payment and may sometimes leads to wasteful investments. See Chapter 6 in Gravelle (1994) for more details. A way to taxing capital gains efficiently is the accrual basis system after correcting for inflation. As proposed by Toder and Viard (2014), gains must

the academic ground, many papers have empirically assessed the impact of the 2003 tax cut (one of the U.S. largest capital and dividend tax cut) and results are mixed between higher dividend payments and no effect on investment (Chetty and Saez, 2006; Yagan, 2015). Because of this apparent debate, a second-best solution is reform 2 whereby corporate tax cut is made up by an increase in dividend tax. In the opposite direction, the less desirable situation is when both dividend and capital gains are used (reform 6). This result comes at odds to that found in Anagnostopoulos et al. (2015) provided that they find this reform to be the optimal tax mix. Firm heterogeneity plays a crucial role in explaining this discrepancy because firms are not at the same stage in productivity level and financial constraint regimes.

4.4 Transitional dynamics

In this section, I present the results of the transitional dynamics following a corporate tax cut for main aggregate macro variables. The first experiment in consideration is a tax cut from 33% to 21% to assess the consequences of the new corporate tax code in the US. The second experiment is about complete elimination of double taxation, namely a 0% corporate tax rate.[22]

4.4.1 Corporate tax cuts with labor income tax adjustment

I first consider an experiment mimicking the corporate tax cut in the Tax Cuts and Jobs Act (2017) of the Trump administration. Before this new law, the U.S. was in fact, one of the OECD countries with the highest tax rate on corporation profit and this may be harmful in a context of international competition provided that corporations could change their location from the U.S. to more advantageous fiscal areas abroad or tax heaven.

In figure 4.3 the corporate tax is cut from 33% to 21% and only labor income tax is allowed to adjust from 28% to 29.42%. At the impact, the labor supply by the household falls by 1% and to the extent that the capital stock is predetermined, the capital-labor ratio increases generating a reduction in the before-tax rate (not plotted). However, the

be taxed whenever there is an increase in their price, and then exempted from any tax once they are sold.

[22]There are 7 basic reforms defined in the current paper, then a complete treatment would require transitional dynamics for each of them. However, for a sake of space I choose to present only the transitional dynamics for reform 1, that is, when labor income tax is used to make up the cut.

after-tax increases by 17.7% in the first period. The tax burden reduction on corporation incentivizes the demand for capital to take advantage of this situation. In turns, dividend payment is reduced given that dividend is the net profit over labor cost and capital depreciation, with the latter increasing alongside the rise in aggregate capital stock. The household total income is then reduced provided that its revenue is composed of labor income and dividend both which collapse in the first period of the transition. The labor supply is reduced in response to the higher tax on labor income. After these periods, the aggregate capital becomes close to its final steady-state value implying an increase in labor demand. These dynamics raise wages and household is now willing to supply more labor but the increase remains small enough, namely around 0.9%. Therefore, interest rate decreases and the firm is willing to pay out more dividend to shareholders, and eventually, the household's income increases allowing it to consume more during the rest of the transition. At the end of the transition periods, capital stock will increase by 13% and aggregate output by 4.7%. Over a 10-period window, the economy is expected to grow by 1.44% which is in line with estimates by the Joint Committee on Taxation (JCT, 2017) projecting an average output growth between 0.8% to 0.9%.

In a second experiment, I allow a complete elimination of double taxation corresponding to a corporate tax of 0%. The effects on the aggregates are depicted in figure 4.4. The dynamics are similar to that of the previous experiment, with just a matter of amplitude in the variables' response. For instance, capital stock increases by 25% from its pre-reform value, and labor supply by 1.5%. The first period is very harmful to the consumer since consumption drops by 7.5% before starting to overtake its pre-reform level after 15 periods. Those large reductions in consumption will be important when assessing the transitional welfare cost of different policy experiments.

4.4.2 *Optimality with transition*

The analysis of the optimality of reforms during the transition is relevant to the extent that the cost borne by the household is explicitly accounted for when a policy experiment moves the benchmark economy to a new state. When the transition is now taken into account, the ranking of reforms with respect to consumption equivalent variation (CEV) is no longer the same as in the steady-state analysis in figure 4.2. A key difference when using figure 4.5 resides in the negativity of CEVs in the transition case. For instance, the optimal reform still remains reform 3 (a double cut in corporate tax and capital gains tax) with a CEV of -0.48%. The negativity means a welfare loss following a tax reform

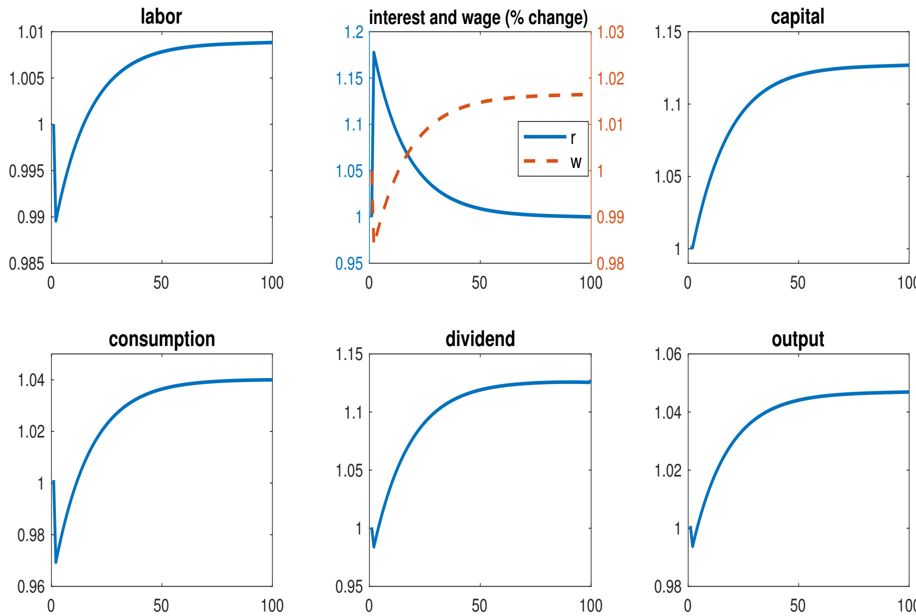


Figure 4.3: Reform 1 with corporate tax of 21%

Note: The panel shows the transitional dynamics of main aggregate macro variables. All variables are computed relatively to their pre-reform steady-state value. The interest and wage rates are the after-tax rates. The horizontal axis is the length of the transition in year. The tax experiment depicted is a cut in corporate tax from 33% to 21% alongside a rise in labor income tax from 28% to 29.42%.

as compared to the pre-reform. In fact, the decrease in consumption during the first periods of transition are very painful for the household implying a large drop in utility even though the consumption rises afterward. Second, one can notice a small change in the ranking between reforms 1,4,7 in the first panel (corporate tax of 21%) meanwhile the ranking in the remaining reforms stays unchanged.

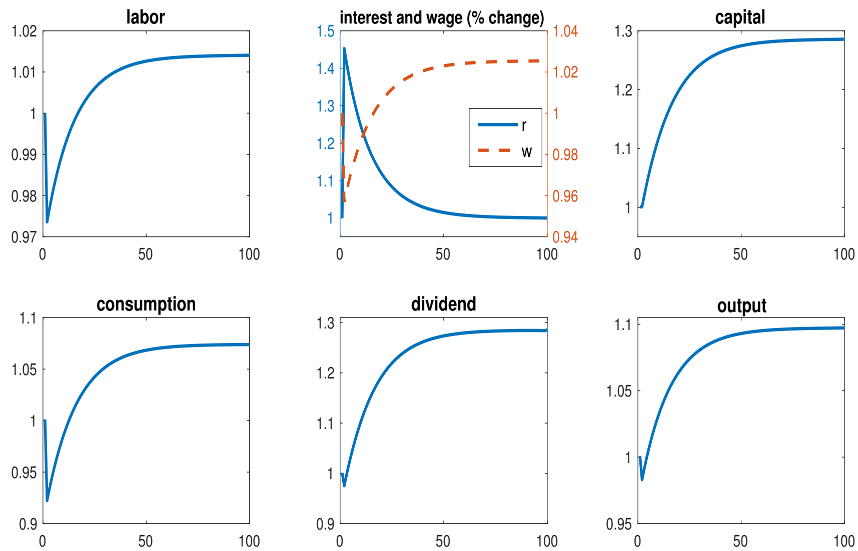


Figure 4.4: Reform 1 with corporate tax of 0%

Note: The panel shows the transitional dynamics of main aggregate macro variables. All variables are computed relatively to their pre-reform steady-state value. The interest and wage rates are the after-tax rates. The horizontal axis is the length of the transition in year. The tax experiment is depicted in the a cut in corporate tax from 33% to 0% alongside a rise in labor income tax from 28% to 31.71%.

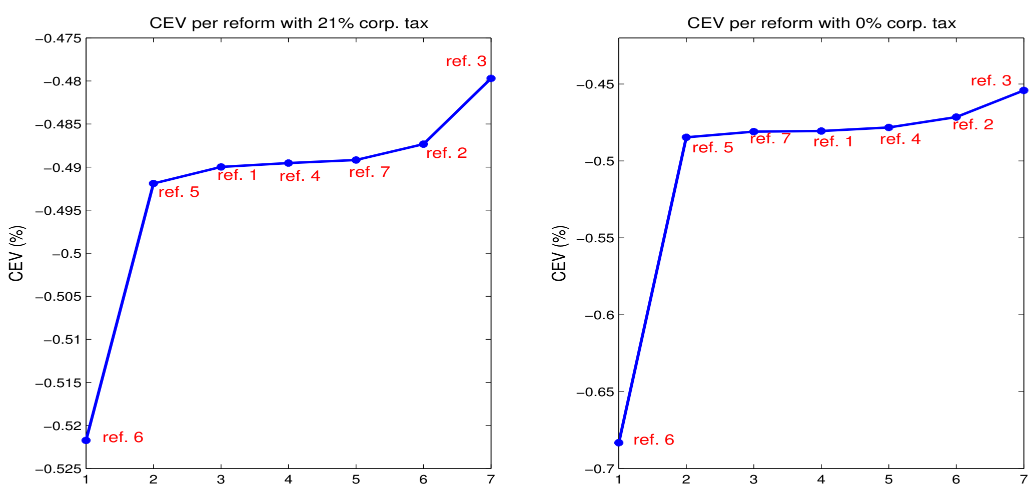


Figure 4.5: Optimal reform with transition

Note: Each blue line in the panel represents the consumption equivalent variation (CEV) needed to compensate the household during transition between the two steady-states in the two tax experiments. The circles are the CEV values and the reform references in red indicate the reforms that generated those values. The horizontal axis only helps construct the graphs and does not have any meaning per se.

4.4.3 *Government budget during transition*

The revenue-neutral condition imposed on the government in the long run in establishing proposition 2 does not preclude any deviation along the transition path. Therefore, an interesting question is to look into the transitional dynamics of the government outlay (G). I construct a government deficit/surplus-output ratio for each transition period which is the difference between period t government expense G_t and the pre-reform constant value G divided by the period t output. Accordingly, the dynamics of all reforms are limned in figure 4.6.

The upper panel represents the case of 21% corporate tax rate. One can at a first glance discriminate three trends. Indeed, reforms 1, 2,4,5 and 7 have almost the same dynamics where the government experiments a deficit during the first periods before starting to resorb that deficit as time goes by. The implementation of reform 3 (double cut in corporate and capital gains tax) generates the largest deficit-output ratio in the first period of transition before equilibrium is reached later on. The large increase (about 2%) in government revenues loss stems from the fact that a drop in capital gain tax reduces stock prices in Eq. (4.25), making the tax collected on the accrual basis lower. However, the positive effect of the capital tax on the long run capital accumulation starts offsetting the previous negative effect on stock price. Subsequently, prices also rise allowing the government to collect more revenues on capital gains even with a lower capital gains tax rate(15.69% instead of the benchmark value of 20%). By contrast, when dividend and capital gains taxes are both raised from 20% to 33.57% to make up the corporate tax cut (reform 6), there is a surplus for the government during the transition. In this scenario, there is no longer distortion in stock prices stemming from a differential taxation provided that capital gains and dividend taxes rates are identical. The increase of 2% at on impact is due to the high level of the taxe rates allowing a collection of more revenue. Given that the rise in capital gains tax directly hurts the capital accumulation, the capital stock and investment start decreasing, and so does the surplus for the government such that the pre-reform outlay is reached in the new steady-state. As a matter of comparison, the deficit-output ration induced by reform 3 (green line) is lower than that generated by the implementation of the TCJA. Indeed, in CBO's projections (CBO, 2019), the federal budget deficit is about \$ 900 billion in 2019 and exceeds \$1 trillion each year beginning in 2022. Over the coming decade, deficits (after adjustments to exclude shifts in the timing of certain payments) fluctuate between 4.1 percent and 4.7 percent of gross domestic product.

The same mechanism holds for the lower panel where corporate tax is completely eliminated or set to 0%. As stated before, the main difference between the two experiments resides in the response amplitude of the different variables. Specifically, the surplus and deficit in reform 6 and reform 3, respectively, are almost 5 to 10 times their counterparts in the 21% corporate tax rate scenario. Recall from table 4.5 that the implementation of reform 6 requires a hike in dividend and capital gains tax from 20% to 92%, which is too much and might seem unrealistic. Given those high tax rates, the capital accumulation is so dampened such a way that all activity is slowed down and then making the government to collect lesser revenue over time.

All in all, this section suggests that there is a trade-off scenario for the government. When pursuing the welfare-maximizing goal, the optimal alternative to implement is to implement reform 3 where corporate tax cut goes along with capital gains tax cut. However, the fiscal-preferred view requires the implementation of reform 6 where a corporate tax cut is offset by a rise in dividend and capital gains taxes, instead. Reform 3 and reform 6 revert each another depending on the planner's final goal.

4.5 Conclusion

Reducing the actual U.S. corporate tax is not a straightforward decision for policymakers provided the forgone revenue which goes along with it. In a basic approach, this paper sheds light on the extent of trade-offs (and lack thereof) such a reform might generate by providing balanced fiscal multipliers related to the instruments used in the long run. Multiplier associated with labor income tax to make up a corporate tax cut is lower in absolute value than that generated by dividend tax since tax burden is easily passed on to shareholders. Also, both multipliers are negative which implies that there is a trade-off between these two tax rates and the corporate tax. Instead, capital gains tax's multiplier is positive which induces a double cut coordination: a cut in corporate induces a cut in capital gains tax rates. A quantitative evaluation of the Tax Cuts and Jobs Act (2017) of the Trump administration wherein corporate tax is cut to 21% from 33%, and the elimination of the double taxation (0%) is carried out. Results suggest that regardless the two proposals, the reform using a double cut in corporate tax and capital gains is the best alternative while the reform where corporate tax cut is offset by a rise in both dividend tax and capital gains tax, ends up the worst-case scenario in welfare-maximizing perspective. However, the previous picture is inverted once the only goal of the policymaker is fiscal neutrality.

This analysis is a partial analysis to the extent that the corporate tax structure is relatively complex. In fact, the U.S. tax code is full of tax deductions such as accelerated depreciation, interest deductibility for debt-financing, making the effective corporate tax lower than the statutory one. As a result, the tax base is shrunk and the forgone deductions are revenue losses for the federal government. A further analysis is, therefore, to explicitly model those deductions alongside the full set of tax instrument used in the present analysis to accurately identify the balanced fiscal multipliers generated by a corporate tax cut.

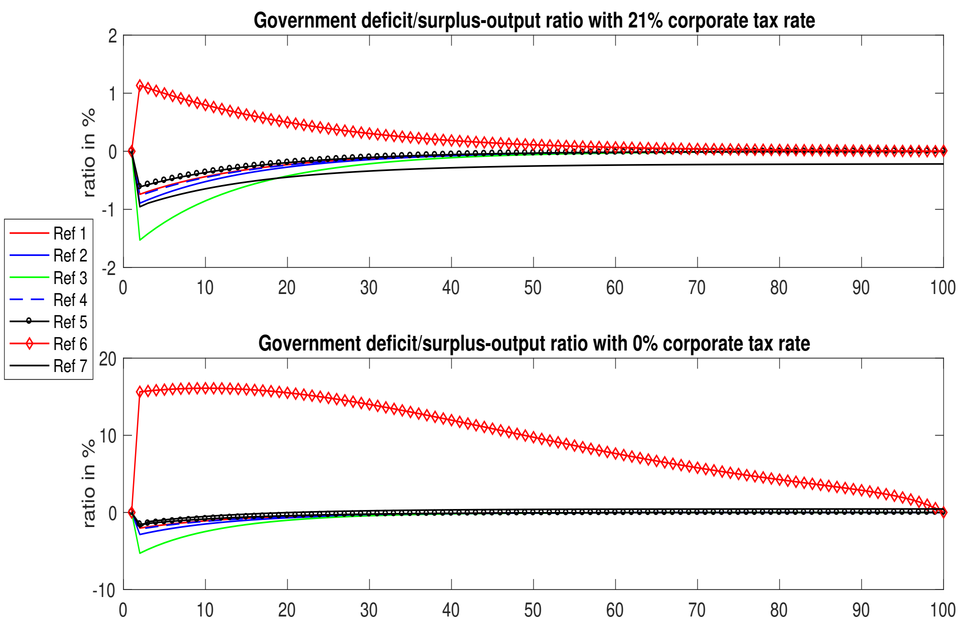


Figure 4.6: Government deficit/surplus-output ratio during transition

Note: Each line in the panel represents the gap between the total tax revenue collected during the transition and the pre-reform government outlay G divided by the corresponding output. Reform 1 to Reform 7 are defined in 3.

Conclusion

This thesis proposed an analysis of the macroeconomics and distributional effects of the taxation of business income in the U.S. economy in four chapters. A dynamic general equilibrium model with occupational choice is developed in Chapter 1 as a mean to emphasize the importance of the cumulative business experience in the income and wealth disparities between individuals over their life cycle. Timely to the recent tax reform of 2017 in the US, Chapter 2 uses the model developed in Chapter 1 to conduct a *positive* analysis of its potential effects on the economy and individuals both in the short run and long run. Acknowledging differences between entrepreneurs and workers in how they affect the economy, Chapter 3 investigates a *normative* question relative to the desirability to tax business owners or entrepreneurs differently from salaried workers. Finally, Chapter 4 focuses on the way to finance a corporate tax cut to meet revenue neutrality for the federal government.

This research finds that the endogenous accumulation of business experience is quantitatively important in providing realistic income and wealth dispersion among individuals. It also makes the argument that the quantitative evaluation of key provisions of the new tax reform (Tax Cuts and Jobs Act) under revenue neutrality shows mitigated results. The reform spurs on average, a small output growth and capital formation over the next decade, meanwhile, wealth and income inequality increases since these tax rebates are mainly targeted to businesses relatively to individuals. In the context of rising inequality, tax policies intended to incentivize entrepreneurial activity is oftentimes subject to opposition in public debates. This thesis underlines the importance of entrepreneurs in the economy and the extent to which the government can tax them differently from salaried workers. As a general result, the optimal flat tax rate is decreasing in the weight the planner places on future cohorts' welfare, but is an increasing function of his aversion for intra-cohort inequality. This result is consistent with other papers using alternative setups without entrepreneurship. Moreover, financing a corporate tax cut through an increase(decrease) on tax rates of other sources of income are possible to meet revenue neutrality for the federal government.

Finally, this thesis provides a ground for future research. An important extension would be to consider the margin of tax avoidance. Indeed, when government tax policies create differences based on sources of income, individuals could recharacterize their income source to take advantage of the tax provisions without adding any positive effect on investment. As an economist aiming to understand the interplay between entrepreneurship and inequality, it is important to deepen the analysis on the heterogeneity amongst individuals. In my dissertation, I considered entrepreneurs as homogeneous with respect to race and gender. However, as pointed out by the Kauffman report on entrepreneurship, minority and women entrepreneurship is on the rise but faces challenges to thrive. As a consequence, another research avenue is to model these issues seriously and analyze how tax policies could affect entrepreneurship in general, but that of women and minority group in particular. For instance, women participation in the labor market is rising and the marriage and fertility decisions may potentially interfere with their sorting into entrepreneurship.

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Annexes

4.6 Appendix of Chapter 1

4.6.1 Labor efficiency units and productivity shock

I use the Panel Study of Income Dynamics (PSID) waves 1968-2011 and collect information on head of households about annual labor income, age, annual hours worked and sex. I include in the sample households whose head *i*) is between 20-64 *ii*) is a male *iii*) and works between 520 and 4368 hours annually[23] (Bakış et al., 2015). Earnings are transformed into 2011 US dollars using Consumer Price Index. For each age cohort, I compute per annum mean labor earnings and mean hours worked. Mean wages are calculated by simply dividing mean earnings by mean hours worked. The endowment of labor efficiency units is determined by dividing each cohort's average wage by the average wage of the selected sample. I use a cubic fit in age to smooth the wage-age profile while controlling for year effects. Figure plots the underlying labor efficiency over the life-cycle.

[23] I also tried an alternative maximal value of 5820 hours as in Huggett et al. (2011) but, results are not affected.

Figure 4.7: Labor efficiency unit over the life-cycle

Below I report the first five values of labor productivity shocks η computed using an approximation of an AR(1) process after Tauchen (1986) as defined in section 3.2.2. Fo this, I set the persistence coefficient ρ and the residual variance ${\sigma_\eta}^2$ to 0.95 and 0.03, respectively (Storesletten et al., 2004). I then add a calibrated awesome state to allow superstars workers in the model.

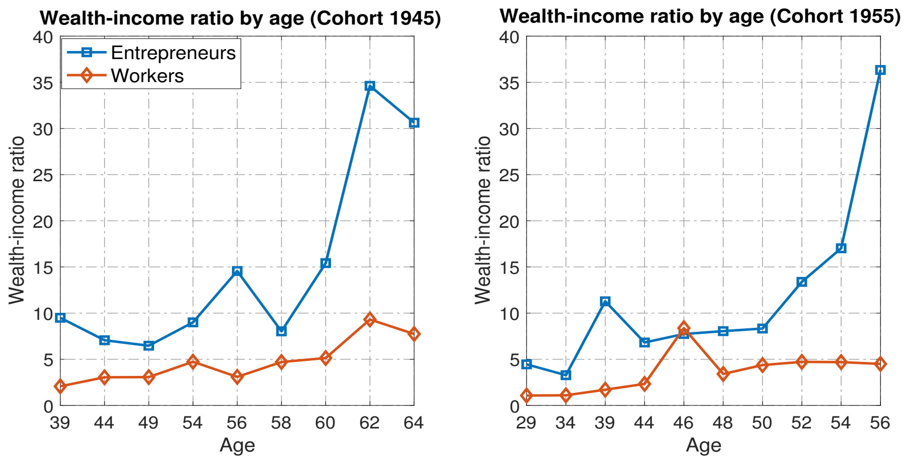
$$\eta = [0.2468, \quad 0.4473, \quad 0.77654, \quad 1.3097, \quad 2.93742, \quad 21.75]$$

$$\Gamma_\eta = \begin{pmatrix} 0.7376(1-0.003) & 0.2473(1-0.003) & 0.0150(1-0.003) & 0.0002(1-0.003) & 0.0000(1-0.003) & 0.003 \\ 0.1947(1-0.003) & 0.5555(1-0.003) & 0.2328(1-0.003) & 0.0169(1-0.003) & 0.0000(1-0.003) & 0.003 \\ 0.0113(1-0.003) & 0.2221(1-0.003) & 0.5333(1-0.003) & 0.2221(1-0.003) & 0.0113(1-0.003) & 0.003 \\ 0.0001(1-0.003) & 0.0169(1-0.003) & 0.2328(1-0.003) & 0.5555(1-0.003) & 0.1947(1-0.003) & 0.003 \\ 0.000(1-0.003) & 0.0002(1-0.003) & 0.0150(1-0.003) & 0.2473(1-0.003) & 0.7376(1-0.003) & 0.003 \\ 0.0000 & 0.0000 & 0.125 & 0.0000 & 0.0000 & 1-0.125 \end{pmatrix}$$

4.6.2 *Extended results on the empirical findings*

The figure below shows the extent to which the consideration of cohort effect can change the result stating that over the life-cycle, entrepreneurs are wealthier than workers. This results still holds. I consider the 1945-cohort and the 1955-cohort to have more age groups.

Figure 4.8: Cohort effect over the life-cycle



4.6.3 *Robustness check with Selection bias*

To the extent that randomness of the choice of occupation might affect the estimation of the earnings function for entrepreneurs, the table below provides a robustness check on the potential of a selection bias relative to occupation. In fact, I implement a two-stage Heckman correction procedure where I use the demeaned value of total business experience at the individual level and its squared value as supplementary predictive variables for the selection probability.

Table 4.6: Heckman two-stage correction model estimation

Heckman selection model – two-step estimates (regression model with sample selection)				Number of obs =	181,857	
				Selected =	11,236	
				Nonselected) =	170,621	
				Wald chi2(40) =	1413.08	
				Prob > chi2 =	0.0000	
Log bus. income	coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Log bus. income						
Age	.1021	.0093	10.92	0.000	.0837	.1204
Age^2	-.0012	.0001	-11.68	0.000	-.0014	-.0010
Experience	.0931	.0103	9.03	0.000	.0729	.1134
Experience^2	-.0028	.0005	-5.56	0.000	-.0038	-.0018
College	.5958	.0276	21.53	0.000	.5416	.6501
Year(*dummies*)			(absorbed)			
cons	8.2732	.2621	31.55	0.000	7.7593	8.7871
selection equation						
Age	.0580	.0034	16.93	0.000	.0512	.0647
Age^2	-.0005	.0000	-13.03	0.000	-.0006	-.0004
demean_exp	.4345	.0059	73.03	0.000	.4228	.4461
demean_exp^2	-.0203	.0002	-72.68	0.000	-.0209	-.0198
1.*College*	.2685	.0123	21.70	0.000	.2442	.2928
Year(*dummies*)			(absorbed)			
cons	-2.9139			0.000	-3.0666	-2.7613
/mills						
lambda	.0881	.0330	2.67	0.008	.0234	.1529
rho	0.0736					
sigma	1.1977					

Note.- Log bus. income is *total income* data from PSID 1968 to 2011 in 2011 US dollars. Age is the age of the head of household, business experience equals the cumulative years of entrepreneurship up to period t, college is a dummy variable and an entrepreneur is a self-employed and business owner. The selection equation also considers the demeaned value of total business experience at the individual level and its squared value.

The table shows that the inverse Mills ratio is positive, suggesting the presence of a selection bias from salary work to entrepreneurship in the data. This can be seen in the positivity of the correlation *rho* between the error terms in the selection equation and primary equation. Therefore, (unobserved) factors that make entrepreneurship more likely tend to be associated with higher incomes. In other words, the average business income of an entrepreneur is greater than the average (potential) business income of a worker. However, the presence of selection bias in the sample does not preclude *business experience* to be a positive predictive factor for entrepreneurs' income as found in table 3.2. Notice also that the estimated coefficient on business experience is now significantly larger than before, this indicates that not considering the selection issue was biasing down the income returns to experience.

4.7 Appendix of Chapter 2

4.7.1 *Main forces : General Equilibrium vs. Partial*

This section sheds light on the main forces underlying the reaction of the different aggregates to the tax cuts implemented via the TCJA.

Table 4.7: Aggregate effects : 20% business income deduction's case

Variables	Benchmark	Deduction provision GE	Deduction provision PE
	Level	%Δ from benchmark	
Output	1.05	2.09	5.05
corporate	0.48	-2.34	-16.90
non corporate	0.57	5.80	23.52
Capital	2.73	5.24	12.95
corporate	1.76	2.20	7.13
non corporate	0.97	10.73	23.51
labor	0.49	-0.63	-2.35
corporate	0.25	-4.60	-28.31
non corporate	0.24	3.38	24.74
Prices			
after-corp-tax interest rate(%)	2.23	-12.46	0.00
wage	1.30	+2.34	0.00
Corp. tax revenue/GDP (%)	1.59	1.39	1.63

Note: GE stands for general equilibrium and PE for partial equilibrium. In the PE case, prices are kept constant to their benchmark values.

Table 4.8: Entrepreneurial statistics: 20% business income deduction's case

Averages	Benchmark	Deduction provision GE	Deduction provision PE
% of entrepreneurs	7.10	7.37	8.35
entry rate(%)	2.61	2.70	3.10
exit rate(%)	20.9	20.50	20.51
tenure in entrepreneurship(yrs)	8.69	8.88	9.22
% of constrained E	25.36	25.45	26.12
asset	10.76	11.47	11.09
capital size	13.70	14.61	14.35
optimal capital size	14.86	16.00	15.37
profitability (%)	18.24	17.34	18.24
tax-to-profit ratio(%)	33.66	26.16	25.82
% of leveraged E (%)	93.55	93.42	94.06

Note: GE stands for general equilibrium and PE for partial equilibrium. In the PE case, prices are kept constant to their benchmark values. Optimal capital is capital invested when firm is unconstrained. Profitability is defined as the ratio of the operating profit to the amount of invested capital. Tax-to-profit is tax paid by a firm out of its profit. Leveraged entrepreneurs is the fraction of firms borrowing from the banking system and the constrained firms are defined as those hitting their borrowing constraint.

Table 4.9: Aggregate effects : top marg. tax cut's case (from 39.6 → 37%)

Variables	Benchmark	Deduction provision GE	PE
	Level	%Δ from benchmark	
Output	1.05	0.45	0.95
corporate	0.48	1.34	-0.90
non corporate	0.57	-0.29	2.50
Capital	2.73	1.90	2.87
corporate	1.76	1.99	2.39
non corporate	0.97	1.74	3.74
labor	0.49	0.18	-0.42
corporate	0.25	1.01	-4.19
non corporate	0.24	-0.66	3.50
Prices			
after-corp-tax interest rate(%)	2.33	-2.01	0.00
wage	1.30	+0.37	0.00
Corp. tax revenue/GDP (%)	1.59	1.58	1.62

Note: GE stands for general equilibrium and PE for partial equilibrium. In the PE case, prices are kept constant to their benchmark values.

Table 4.10: Entrepreneurial statistics : top marg. tax cut's case (from 39.6 → 37%)

Averages	Benchmark	top marg. tax cut's case GE	PE
% of entrepreneurs	7.10	6.93	7.11
entry rate(%)	2.61	2.55	2.63
exit rate(%)	20.9	20.9	20.87
tenure in entrepreneurship(yrs)	8.69	8.66	8.72
% of constrained E	25.36	24.98	25.14
asset	10.76	11.30	11.18
capital size	13.70	14.27	14.15
optimal capital size	14.86	15.58	15.37
profitability (%)	18.24	17.75	17.92
tax-to-profit ratio(%)	33.66	32.86	32.76
% of leveraged E (%)	93.55	93.13	93.31

GE stands for general equilibrium and PE for partial equilibrium. In the PE case, prices are kept constant to their benchmark values. Optimal capital is capital invested when firm is unconstrained. Profitability is defined as the ratio of the operating profit to the amount of invested capital. Tax-to-profit is tax paid by a firm out of its profit. Leveraged entrepreneurs is the fraction of firms borrowing from the banking system and the constrained firms are defined as those hitting their borrowing constraint.

4.7.2 *Some details about key provisions as written in the Law and sensibility analysis*

In the tables below, I provide certain details about the provisions in the new tax bill. However, the information are still highly summarized since the tax code describes many aspects of each provision and also gives the conditions under which it can be applied.

Table 4.11: Tax Cuts and Job Act (TCJA): reform of 2017

Key provisions	All	Bus. deduction	Corp. cut	Top cut	Bonus depreciation
Deduction for pass-throughs' income: $\tau_d^{bench} = 0\% \rightarrow \tau_d^{new} = 20\%$	X	X			
Corporate tax cut: $\tau_c^{bench} = 29\% \rightarrow \tau_c^{new} = 21\%$	X		X		
Top marginal tax cut: $\tau_{\max}^{bench} = 39.6\% \rightarrow \tau_{\max}^{new} = 37\%$	X			X	
Bonus depreciation: $\varphi^{bench} = 1 \rightarrow \varphi^{new} = 1.2$	X				X

	Key provisions	Conditions
Businesses		
- Coprorations	New Flat tax rate of 21%	Permanent
- Pass-throughs	New 20-percent deduction for qualified business income	Temporary (2018-2025). Limits apply based on income and type of business. For instance, if your 2018 taxable income is below $315,000, if married filing jointly, or $157,500 for all other filing statuses, it doesn't matter, what type of business you are in. You will be able to deduct the lesser of: a) Twenty percent (20%) of your Qualified Business Income (QBI), or b) Twenty percent (20%) of your taxable income minus your net capital gains.
- All	New 100-percent bonus depreciation deduction for businesses	100% the first five years(2018-2022) before phasing out at 20% rate until 2026
Individuals	Reduction in marginal tax rates 10%, 15%, 25%, 28%, 33%, 35% and 39.6% to 10%, 12%, 22%, 24%, 32%, 35% and 37% There is also a reduction in the income brackets based on the filling status.	Temporary (2018-2025)

Source: Internal Revenue Service (IRS). More details at https://www.irs.gov/newsroom/tax-reform-guidance

In the new tax law, businesses are allowed to take advantage of a new accelerated depreciation or bonus depreciation. Since this provision is more prevalent in the corporate sector relative to pass-through entities, I then introduce the parameter $\varphi \geq 1$, which controls for the bonus depreciation rule. In the benchmark its value is $\varphi = 1$, but the new tax bill allows 100% bonus depreciation (for new and used assets). Therefore the reformed valued will be $\varphi > 1$ during the first five years(2018-2022) before phasing out at 20% rate each year until 2026. In 2027, this provision sunsets. In this section I perform as a robustness check of the effects of key provisions of the TCJA accounting for bonus depreciation. To do so, I rely on the change of the value of the user cost of capital used by Barro and Furman (2018). Indeed, the user cost of capital takes account of literal expensing, depreciation allowances, and investment tax credits. They find that the user cost will change from 0.8 to 1 which represents a 0.2 unit change. Therefore I assume that the parameter of the bonus depreciation also changes from $\varphi = 1$ to $\varphi = 1.2$. The corporate firm then solves the following static problem which generates the rental price for capital and labor inputs:

$$\max_{K_c, L_c > 0} (1 - \tau_c) \underbrace{\left(A_c F(K_c, L_c) - \varphi \delta K_c - w L_c\right)}_{operating\ profit} - r K_c \tag{4.32}$$

First order conditions give rise to

$$r = (1 - \tau_c) \left[\alpha A_c \left(\frac{K_c}{L_c} \right)^{\alpha - 1} - \varphi \delta \right] \tag{4.33}$$

$$w = (1 - \alpha) A_c \left(\frac{K_c}{L_c} \right)^{\alpha} \tag{4.34}$$

$\frac{\partial r}{\partial \varphi} < 0$: an increase in bonus depreciation for corporations reduces the user cost of capital (here the after-tax rate) and this should increase the investment made by corporations. However, in a general equilibrium setup, the after-tax also represents the return on risk free asset, and its decline might reduce the incentives for households to save.

Furthermore, in the main text, I assumed that any pass-through owner is entitled to deduct the new 20% provision. Nonetheless, the tax code imposes some limits relative to the industry and the income level. Since my model does not have the industry margin, I only consider in this section a check on the income threshold. Let y and y^d be the gross income and the disposable income of an entrepreneur, respectively. The taxable income $y^{taxable}$ is given by:

$$y^{taxable} = \begin{cases} (1 - \tau_d) y \text{ if } y \leq y^{max} \\ y \text{ if } y > y^{max} \end{cases}$$

and the disposable income y^d using the progressive tax schedule is as follows:

$$y^d = \xi \min\{y_{top}, y^{taxable}\}^{1-\tau} + (1 - \tau_{\max}) \max\{0, y^{taxable} - y_{top}\} + \tau_d \cdot y \mathbb{1}_{\{\text{ if } y \leq y^{max}\}}$$

y^{max} represents the level of qualified business income above which households cannot longer claim the new deduction provision. In 2017, this threshold is U.S. $315,000, or 3.6 times average household income. y_{top} is the income threshold beyond which the household starts paying the top marginal tax rate.

The results of accounting for the two previous provisions are provided in the table below. A comparative analysis with table 2.8 in section 2.5.1 shows that their long-run effect is negative since they dampens the changes in the level of the different aggregates. For instance, the new 20% deduction is no longer available for top entrepreneurs and since their saving rate is higher, the tax incentives are not totally unleashed as in section 2.5.1. Furthermore, the new bonus depreciation when evaluated solely even generates a negative growth in capital and output level. The intuition is a follows, the increase in depreciation allowances reduces the after-corporate tax user cost of capital (r). This should augment the corporate investment. However, in this general equilibrium setting, the interest rate represents also the return on risk free asset (or corporate dividends), but its reduction disincentivizes households to save more. This channel therefore decreases the capital available to the corporate sector.

Table 4.12: Aggregate effects of the TCJA in the long run

		Key provisions of the TCJA				
Variables	Benchmark	**All**	**bus deduction**	**corp cut**	**top cut**	**bonus depr.**
	Level	%Δ from benchmark				
Output	1.05	1.17	1.22	0.04	0.45	-0.70
corporate	0.48	-6.78	-3.04	1.63	1.34	-5.97
non corporate	0.57	7.69	4.80	-1.30	-0.29	3.57
Capital	2.73	1.60	2.25	0.38	1.90	-3.23
corporate	1.76	-4.40	-.02	1.71	1.99	-7.69
non corporate	0.97	12.44	6.37	-2.01	1.74	4.85
labor	0.49	-1.27	-1.11	0.14	0.18	-0.68
corporate	0.25	-9.54	-6.17	1.59	1.01	-6.67
non corporate	0.24	7.33	4.15	-1.32	-0.66	5.56
Prices						
after-corp-tax interest rate	2.33	-37.43	-8.75	+11.13	-2.01	-31.52
wage	1.29	+1.30	+1.50	-0.02	+0.37	-1.04
Corp. tax revenue/GDP (%)	1.59	0.64	1.44	1.17	1.58	1.07

4.8 Appendix of Chapter 3

4.8.1 Some results in the optimal steady-state regime

This section sheds light on the direct and also the general equilibrium effects once the planner changes the tax code.

Table 4.13: Entrepreneurial statistics under optimal flat rate regime(steady state)

		Optimal	
Averages	Benchmark	GE	PE
% of entrepreneurs	7.10	5.78	5.65
entry rate(%)	2.62	2.05	2.01
exit rate(%)	20.92	20.87	20.87
tenure in entrepreneurship(yrs)	8.65	8.73	8.63
% of constrained E	25.36	24.26	23.15
% of E paying less than the opt. flat tax	44.12	0.00	0.00
asset	10.76	13.70	13.81
capital size	13.69	17.28	17.37
optimal capital size	14.87	19.14	19.13
profitability (%)	24.07	21.54	21.29
tax-to-profit ratio(%)	33.67	26.75	26.70
% of leveraged Es	93.91	92.21	91.70

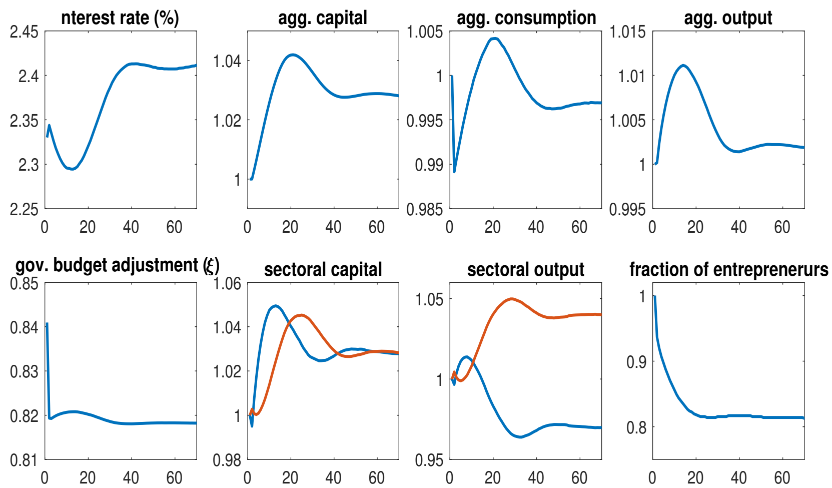
Note: Optimal capital is capital invested when firm is unconstrained. Profitability is defined as the ratio of the operating profit to the amount of invested capital. Tax-to-profit is tax paid by a firm out of its profit. Leveraged entrepreneurs are the fraction of firms borrowing from the banking system and the constrained firms are defined as those hitting their borrowing constraint. GE stands for general equilibrium and PE, for partial equilibrium.

Table 4.14: Distribution of effective tax rate (%)

	Pre-tax income percentiles				
Workers	All	< 0.50	0.50-0.90	0.90-0.99	1%
Benchmark	20.36	-1.00	14.01	28.84	38.65
Optimal	21.96	1.68	16.09	30.28	38.80
Entrepreneurs					
Benchmark	30.60	-1.90	16.87	31.35	37.13
Optimal	24.00	24.00	24.00	24.00	24.00
All (+ retirees)					
Benchmark		-2.16	13.98	29.65	38.08
Optimal	20.58	0.63	16.51	28.37	32.87

Note: Effective tax rate is the ratio of income tax paid to pre-tax income.

Figure 4.9: Evolution of aggregate quantities: Steady state to Optimal regime (25%)



Note: Transition to differential taxation - values relative to the benchmark economy, except for r and the parameter ξ balancing the government budget. The new tax system with a flat rate τ_e = 27% solely for entrepreneurs goes into effect at t = 1. The years of transition are on the x-axis.

4.9 Appendix

4.9.1 Proof of proposition 2

Proof. The proof of proposition 2 is based on total differentiation of the government budget in the steady-state defined in equation 4.31 and the imposition of the balanced budget constraint thereafter. Recall government budget from equation 4.31

$$G = \tau_d D(\tau_c, \tau_l, K^\nu(\tau_l, \tau_g, \tau_c)) + (1-\alpha)\tau_l B(\tau_l) K^\nu(\tau_l, \tau_g, \tau_c) + \frac{\tau_c}{1-\tau_c} D(\tau_c, \tau_l, K^\nu(\tau_l, \tau_g, \tau_c)) \quad (4.35)$$

Taking total differentiation of equation the above equation one obtains

$$dG = d\Big(\tau_d D(\tau_c, \tau_l, K^\nu(\tau_l, \tau_g, \tau_c))\Big) + d\Big((1-\alpha)\tau_l B(\tau_l) K^\nu(\tau_l, \tau_g, \tau_c)\Big) + d\Big(\frac{\tau_c}{1-\tau_c} D(\tau_c, \tau_l, K^\nu(\tau_l, \tau_g, \tau_c))\Big) \quad (4.36)$$

$$d\Big(\tau_d D(\tau_c, \tau_l, K^\nu(\tau_l, \tau_g, \tau_c))\Big) = d\tau_d D + \tau_d \left[\frac{dD}{d\tau_c} d\tau_c + \frac{dD}{d\tau_l} d\tau_l + \nu K^{\nu-1} \frac{dD}{dK}\frac{dK}{d\tau_l} d\tau_l + \frac{dD}{dK}\frac{dK}{d\tau_g} d\tau_g + \frac{dD}{dK}\frac{dK}{d\tau_c} d\tau_c\right] \quad (4.37)$$

$$d\Big((1-\alpha)\tau_l B(\tau_l) K^\nu(\tau_l, \tau_g, \tau_c)\Big) = (1-\alpha) B K^\nu d\tau_l + (1-\alpha)\tau_l K^\nu \frac{dB}{d\tau_l} d\tau_l + (1-\alpha)\tau_l B\left[\nu K^{\nu-1}\frac{dK}{d\tau_l} d\tau_l + \nu K^{\nu-1}\frac{dK}{d\tau_g} d\tau_g + \nu K^{\nu-1}\frac{dK}{d\tau_c} d\tau_c\right] \quad (4.38)$$

$$d\Big(\frac{\tau_c}{1-\tau_c}D(\tau_c,\tau_l,K^\nu(\tau_l,\tau_g,\tau_c))\Big) = \frac{d\tau_c}{(1-\tau_c)^2}D + \frac{\tau_c}{1-\tau_c}\Bigg[\frac{dD}{d\tau_c}d\tau_c + \frac{dD}{d\tau_l}d\tau_l + \nu K^{\nu-1}\frac{dD}{dK}\frac{dK}{d\tau_l}d\tau_l + \frac{dD}{dK}\frac{dK}{d\tau_g}d\tau_g + \frac{dD}{dK}\frac{dK}{d\tau_c}d\tau_c\Bigg] \quad (4.39)$$

Summing up equations 4.36 to 4.39 and grouping with respect to τ_c, τ_l and τ_g implies

$$\begin{aligned} dG = d\tau_d D + d\tau_c\Bigg[&\frac{dD}{d\tau_c} + \nu K^{\nu-1}\frac{dD}{dK}\frac{dK}{d\tau_c} + \nu(1-\alpha)\tau_l BK^{\nu-1}\frac{dK}{d\tau_c} + \frac{D}{(1-\tau_c)^2} + \frac{\tau_c}{1-\tau_c}\frac{dD}{d\tau_c} + \frac{\nu\tau_c}{1-\tau_c}K^{\nu-1}\frac{dD}{dK}\frac{dK}{d\tau_c}\Bigg] \\ + d\tau_l\Bigg[&\frac{dD}{d\tau_l} + \nu K^{\nu-1}\frac{dD}{dK}\frac{dK}{d\tau_l} + (1-\alpha)\tau_l BK^\nu + (1-\alpha)\tau_l K^\nu\frac{dB}{d\tau_l} + \nu(1-\alpha)\tau_l BK^{\nu-1}\frac{dK}{d\tau_l} + \frac{\tau_c}{1-\tau_c}\frac{dD}{d\tau_l} + \frac{\tau_c}{1-\tau_c}\nu K^{\nu-1}\frac{dD}{dK}\frac{dK}{d\tau_l}\Bigg] \\ + d\tau_g\Bigg[&\tau_d\nu K^{\nu-1}\frac{dD}{dK}\frac{dK}{d\tau_g} + \nu(1-\alpha)\tau_l BK^{\nu-1}\frac{dK}{d\tau_g} + \frac{\tau_c}{1-\tau_c}\nu K^{\nu-1}\frac{dD}{dK}\frac{dK}{d\tau_g}\Bigg] \end{aligned} \quad (4.40)$$

Let's denote by $e_{x/\tau}$ the elasticity of variable X with respect to a tax rate, where $X \in \{D, K\}$. Defining

$$e_{x/\tau} = \frac{dX}{d\tau}\frac{\tau}{X}$$

A bit of algebra gives rise to

$$\Phi = \Big(\frac{\tau_d}{\tau_c} + \frac{1}{1-\tau_c}\Big)\Big(e_{d/\tau_c} + \nu K^{\nu-1}e_{d/k}e_{k/\tau_c}\Big)D + \frac{\nu(1-\alpha)\tau_l B(\tau_l)K^\nu}{\tau_c}e_{k/\tau_c} + \frac{D}{(1-\tau_c)^2} \quad (4.41)$$

$$\Psi = \left(\tau_d + \frac{\tau_c}{1-\tau_c}\right)\left(e_{d/\tau_l} + \nu K^{\nu-1} e_{d/k} e_{k/\tau_l}\right)\frac{D}{\tau_l} + (1-\alpha)(1+\nu e_{k/\tau_l})B(\tau_l)K^{\nu} + (1-\alpha)\tau_l K^{\nu}\frac{dB}{d\tau_l} \tag{4.42}$$

$$\Omega = \frac{\nu K^{\nu-1} e_{k/\tau_g}}{\tau_g}\left[\left(\tau_d + \frac{\tau_c}{1-\tau_c}\right)D \cdot e_{d/k} + (1-\alpha)\tau_l B(\tau_l) K\right] \tag{4.43}$$

Using the condition revenue-neutral or balanced budget condition i.e. $dG = 0$, proposition 2 follows

$$d\tau_c = -\Phi^{-1}\left[D \cdot d\tau_d + \Psi \cdot d\tau_l + \Omega \cdot d\tau_g\right] \tag{4.44}$$

□

4.9.2 *Trade-offs without revenue neutrality*

The proposition 2 in the main text discussed the case of revenue neutrality. However, exogenous change such as population aging, wars could prevent the revenue neutrality condition to be satisfied by the government. Accordingly, a general version of proposition 2 is given as follows

$$d\tau_c = -\Phi^{-1}\left[D \cdot d\tau_d + \Psi \cdot d\tau_l + \Omega \cdot d\tau_g - dG\right] \tag{4.45}$$

where $dG \lesseqgtr 0$ is the level change in the government outlay.

Let's assume that the corporate tax cut is financed only by labor income tax. Similarly, one can discuss the cases where the tax cut is offset by dividends and/or capital gains taxes. Equation 4.45 becomes

$$d\tau_c = -\Phi^{-1}\left[\Psi \cdot d\tau_l - dG\right] \tag{4.46}$$

$$d\tau_l = -\Psi^{-1}\Phi \cdot d\tau_c + \Psi^{-1} \cdot dG \tag{4.47}$$

Consider that $d\tau_l^{g1} = \tau_l^{g1} - \tau_l$ is the change in the labor income tax when there is no neutrality with τ_l the benchmark labor income tax. In the case of revenue neutrality , we define $d\tau_l^{g0} = \tau_l^{g0} - \tau_l$. Interestingly, we can ask how τ_l^{g1} compare to τ_l^{g0}. Let's re-write equation 4.47 with these notations:

with revenu neutrality:

$$d\tau_l^{g0} = -\Psi^{-1}\Phi \cdot d\tau_c^{g0} \tag{4.48}$$

without revenu neutrality:

$$d\tau_l^{g1} = -\Psi^{-1}\Phi \cdot d\tau_c^{g1} + \Psi^{-1} \cdot dG \tag{4.49}$$

Next, let's assume that the multipliers Ψ and Φ are constants in both economies, and the government pursues the same level change in the corporate tax rate ($d\tau_c^{g0} = d\tau_c^{g1} = d\tau_c$). Therefore, taking the difference between 4.49 and 4.48 gives rise to

$$d\tau_l^{g1} - d\tau_l^{g0} = \tau_l^{g1} - \tau_l^{g0} = \Psi^{-1} \cdot dG \tag{4.50}$$

Specifically,

$$\tau_l^{g1} = \tau_l^{g0} + \Psi^{-1} \cdot dG \tag{4.51}$$

1. $dG > 0$: *Increased spending*

   - If the multiplier $\Psi^{-1} > 0$ then $\tau_l^{g1} > \tau_l^{g0}$. This will be the case predicted with the current parametrization of the benchmark economy. Since the government outlay is entirely financed by tax revenue, therefore the more spending is projected the higher the labor tax will be as compared to the economy keeping the benchmark's government expenditure level.
   - Otherwise, $\Psi^{-1} < 0$ implies $\tau_l^{g1} < \tau_l^{g0}$. In this case, increasing the government outlay requires that the labor income tax be lowered relative to the labor income induced by the revenue neutrality condition one.

2. $dG < 0$: *Reduced spending*

   - When the multiplier $\Psi^{-1} > 0$, we have $\tau_l^{g1} < \tau_l^{g0}$. This alternative is the symmetric of the case where $dG > 0$. If for an exogenous reason the government has to reduce its spendings, then it must also set a new labor income tax mower than that predicted when revenue neutrality is required.

- if $\Psi^{-1} < 0$, $\tau_l^{g1} > \tau_l^{g0}$. Here, lowering the expenditures induces government to increase the labor income tax with respect to that predicted by the case of revenue neutrality.

4.9.3 *Proof of lemma 1*

Proof. Here I give a sketch of the proof for reform 1 since that of the remaining reforms are akin. As explained in the main text, the implementability condition gives conditions under which one has trade-offs in each of reform implemented. Once this condition does not hold, the assumption of any trade-off falls and a cut goes along with another cut.

Let's assume that only-labor income tax reform is implemented, this implies that $d\tau_d = d\tau_g = 0$. We denote τ_l^0 the initial or benchmark value of the labor income tax rate and τ_l the after-reform tax rate , then $d\tau_l = \tau_l - \tau_l^0$. By equation 4.44 we have

$$d\tau_c = -\Phi^{-1}\Psi d\tau_l \tag{4.52}$$

To the extent that we are interested in corporate tax cut, $d\tau_c < 0$ by definition. Also, the assumption of trade-off implies that $d\tau_l > 0$. Therefore, equality 4.52 is satisfied without contradiction if and only if $\Phi^{-1}\Psi > 0$.

The second part of the implementability condition uses the assumption that $\tau_l < 1$.

Using equation 4.52, $d\tau_l = -\Phi\Psi^{-1}d\tau_c \Rightarrow \tau_l = \tau_l^0 - \Phi\Psi^{-1}d\tau_c$. Hence, with $\tau_l < 1$, we finally get $d\tau_c > (\tau_l^0 - 1)\Psi\Phi^{-1}$. This ends the proof. □

4.9.4 *Sensitivity analysis to the Frisch elasticity*

The deep parameters used in the calibration of the model presented in section 4.3.2 are standard. However, as discussed above, the inverse of the curvature of hours worked $(1/\sigma)$ or the Frisch elasticity of labor does not have a very well-established value. In the benchmark, I choose a value $\sigma = 1.7$ yielding a Frisch elasticity of 0.6. This is somewhat higher than micro levels estimates which are around 0.25 (Blundell and MaCurdy, 1999) but discussing Frisch elasticity thorough micro and macro estimates Chetty et al. (2011) recommend higher values around 0.75 in representative macro models. In this section, I perform a sensitivity test to see how the elasticities of some macro-variables with respect to the different tax rates change when the Frisch elasticity of labor decreases or increases. The other parameters are kept at their benchmark values in all experiments.

Table 4.15: Sensitivity analysis for elasticities and multipliers

		Frisch elasticity ($1/\sigma$)		
Definition	Variables	0.5	Benchmark (0.7)	0.9
elasticity of dividends w.r.t. corporate tax	$e_{d/c}$	-0.3635	-0.3726	-0.4047
elasticity of dividends w.r.t. capital	$e_{d/k}$	-0.3550	-0.3220	-0.2171
elasticity of dividends w.r.t lab. tax	$e_{d/l}$	-0.1944	-0.2288	-0.3500
elasticity of capital w.r.t corporate tax	$e_{k/c}$	-0.3635	-0.3726	-0.4047
elasticity of capital w.r.t capital gains tax	$e_{k/g}$	-0.1845	-0.1891	-0.2054
elasticity of capital w.r.t lab. tax	$e_{k/l}$	-0.1944	-0.2288	-0.3500
steady-state multiplier Φ	Φ	0.0359	0.0270	0.0082
steady-state multiplier Ψ	Ψ	0.3087	0.2462	0.1066
steady-state multiplier Ω	Ω	-0.0411	-0.0369	-0.0248

Note: w.r.t stands for with respect to.

I report in table 4.15 the result of the sensitivity check. Two aspects are revealed in this table. First, the absolute value of the elasticities is increasing in the Frisch elasticity of labor. This means that when the household labor supply becomes more sensitive to the change in the wage rate, the aggregate variable of the economy react more. The level change in the different values are relatively modest across the realistic value of the Frisch elasticity of labor. Second, the absolute value of the steady-state multipliers (Φ, Ψ, Ω) decreases with the Frisch elasticity. It also suggests that the household labor supply is important in predicting the tax trade-off discussed in this paper. Recalling from proposition 2, the different multipliers enter inversely in the equation that determines the extent to which any tax rate has to be adjusted to make up a cut in the corporate tax rate. Therefore, the lower the multiplier, the higher its inverse value and the corresponding level change in the associated tax rate (labor income tax, dividends tax and capital gains tax).