Job creators, job creation and the tax code.

Adrian Masters
Department of Economics
University at Albany, SUNY
1400 Washington Avenue
Albany, NY 12222
amasters@albany.edu

June 19, 2015

Abstract

This paper considers the role of the tax code in determining income dispersion and vacancy creation. A "span-of-control" model is embedded into a search and matching environment. A cut to the tax on profits in isolation improves job creation and reduces before-tax income inequality. The impact of a budget-balancing increase in the wage tax depends on the bargaining power of firms. When it is high, firms pick up the lion's share of the tax burden. The tax acts like a barrier to entry: it benefits large firms at the expense of marginal ones. Net effects are an increase in unemployment and before-tax income dispersion. Low firm bargaining power means workers pick up more of the tax burden. It acts like a subsidy to entrepreneurship reinforcing the impact of the profit tax reduction. Taxes on the returns to capital leave everyone worse off.

"Tax hikes destroy jobs – especially an increase on the magnitude set for January 1st." John Boehner's address to Peter G. Peterson Foundation 2012 Fiscal Summit.

> "We need serious tax reform to make the tax code fairer and simpler. The most profitable corporations should have to pay their fair share...those who already have made it big have a responsibility to pay a little bit forward - so the next kid coming along has a chance to make it too." Elizabeth Warren for Senate, Issues website.

1 Introduction

Depending on your political position, lowering taxes on profits either stimulates vacancy creation or exacerbates income inequality. These assertions are not mutually exclusive. The goal of this paper is to provide a parsimonious model of entrepreneurship and job creation to understand when and how either or both of them can be true.

The model embeds ex ante heterogeneity in embodied entrepreneurial ability into a search and matching framework. Individuals choose to either establish a firm or remain as a worker. Individual firm owners receive rents in the form of profits above those accruing to the marginal entrepreneur. Taken in isolation, a cut in the tax rate on profits increases the return to entrepreneurship – more firms are created and unemployment falls. Because there are more firms to share a reduced population of workers, before-tax profits decline. In the longer-term, however, the government must balance its budget. This is achieved in the model by raising the tax on wages, the impact of which depends on the bargaining power of the firms. When it is high, firms pick up the lion's share of the tax burden in the form of a wage increase. The tax acts like a barrier to entry which benefits large firms at the expense of marginal ones. The net effects are an increase in unemployment and before-tax income dispersion. Low firm bargaining power means workers pick up more of the increased wage-tax burden and it acts like a subsidy to entrepreneurship. This reinforces the impact of the profit-tax reduction.

The framework introduces the Lucas (1978) "span-of-control" model into a Diamond-Mortensen-Pissarides (DMP) style search and matching environment. As in Lucas's model, anyone can choose to be either a worker or an entrepreneur/firm owner. There is ex ante heterogeneity in terms of individuals' entrepreneurial abilities but as a worker everyone is equally productive. Consequently, there is a threshold level of entrepreneurial ability above which individuals choose to establish a firm and below which they do not. Firms hire workers through a DMP environment that is governed by a matching function.

In a departure from the usual DMP set-up, I allow firms to hire multiple workers.[1] Firms effectively operate a standard neoclassical production function with constant returns to scale. Factors of production are capital and labor. Although there are diminishing returns to each factor, when a worker is hired the firm acquires the appropriate amount of additional capital through a competitive market. Output is therefore linear in the number of workers. Total factor productivity (TFP) of the firm is specified by the owner's entrepreneurial ability level. Firms are continually in the labor market and they hire whomever they meet. What prevents them from growing without bound is that, as is common in the DMP framework, there is an exogenous rate of separation. Consequently, the number of workers at any firm is (ergodically) Poisson distributed. With a constant rate of separation, the parameter of the Poisson distribution is determined by the matching rate.

Workers can observe the firm's TFP and they direct their search accordingly. Wage formation is by Nash bargaining.[2] As the effective marginal product of the workers is constant, the wage depends on the firm's TFP but not on the current number of employees. Higher TFP means higher marginal productivity and higher wages. More workers, therefore, seek employment at the higher TFP firms and such firms experience a higher matching rate. So, not only do the highest ability entrepreneurs receive higher rents from each employee, they also (in expectation) have more of them.

In this context, the paper asks how the tax code affects vacancy creation and the relative earnings of the high ability entrepreneurs. Like Lucas (1978) the model lacks a general pyramidal organizational structure with several layers of management in each firm. The model cannot, therefore, empirically match both the firms' size and income distributions. Here, the focus is on the income distribution. The central exercise is then to set the tax on profits to 15% and set the wage-tax so as to generate revenues at 18.6% of GDP. Then, a common tax rate is sought to generate the same tax revenue. To

[1] Other papers that incorporate multiple-worker firms in a matching environment include Burdett and Mortensen (1998), Acemoglu and Hawkins (2014), and Shimer (2006).

[2] Some researchers have criticized directed search because it has historically relied on both posted wages and full commitment to those wages while there is little evidence that either aspect of the wage formation process is true (see Menzio 2007 and Masters 2011). Here, there is no commitment issue and in equilibrium, at least, entrepreneurial ability will be evident by the behavior of the firm.

separately identify the effects of the tax on profits from the tax on wages I report the incremental results as the economy moves from the equal to the unequal tax regime.

Central to the literature on the calibration of DMP models is the value of the bargaining power parameter. The crucial point is that setting the bargaining power of the firms equal to the elasticity of the matching function with respect to vacancies (the Hosios Rule) implements the constrained efficient allocation. Estimates of the elasticity of the matching function (see Petrongolo and Pissarides 2001) range between 0.3 and 0.7 with most people using 0.5. Meanwhile, empirical studies of micro data imply that the bargaining power of the firms exceeds 0.95 (see Card et al 2014). The problem is that such a bargaining power puts the laissez-faire economy so far from efficiency as to stretch credulity. Consequently, I provide two separate parameterizations which serve to demonstrate the workings of the model. The first based on the empirical measures of the bargaining power (I use 0.96) and the second based on the Hosios (1990) result (I use 0.5).

In both cases we see that the reduction of profit-taxes in isolation increases the return to entrepreneurship, job creation improves, before-tax profits decline and after-tax profits rise. The impact of the budget-balancing increase in the wage-tax depends on the parameterization. With the bargaining power of firms set to 0.96, the increased wage-tax pushes up the wage, increases unemployment, and decreases the number of entrepreneurs. Moreover, the high ability entrepreneurs fare much better than their lower ability counterparts. Under the Hosios Rule, the change in the wage-tax has little effect on the wage and tends to strengthen the effects of the profit-tax.

So, how a change in the tax code impacts vacancy creation and income dispersion comes down to the impact of an increase in the wage-tax on before-tax wages. To see why this effect is stronger when firms have a lot of bargaining power, consider what happens if they have all of the bargaining power. Then, all workers get the same pay that (after tax) will just compensate them for their disutility of work. An increase in the tax on wages is fully absorbed by firms in the form of a wage increase. When firms have lower bargaining power, workers pick up some of the increased tax burden.

A second difference between the results is that with high bargaining power, entrepreneurial rents are large which means that the tax adjustments on profits and wages are both large. (They move from 28.2% to 15% and from 28.2 to 39% respectively.) The wage-tax effects outweigh the profit-tax effects so that a switch from the equal to the unequal tax regime leads to higher unemployment and entrepreneurs higher in the distribution of ability experiencing higher taxable income growth. Under the Hosios Rule, entrepreneurial rents are small so that the tax adjustment on profits is much larger (27.8% to 15%) than the adjustment to the wage-tax (27.8% to 28.7%). In this case the impact of the profit-tax changes are also much larger. (In any case, at the Hosios Rule the two adjustments tend to move the economy in the same direction.) Entrepreneurship becomes more popular and unemployment falls. After-tax incomes for higher ability entrepreneurs do rise more than those of lower ability but their before-tax incomes decline.

There is a large and growing literature on the relationship between the top tax rates and pre-tax incomes in general (see Saez et al 2012). Specific focus on the taxable incomes of high earners has been less extensively analyzed. Piketty et al (2011) is an exception. While they find that there is strong evidence that lowering tax rates on the rich increases their taxable incomes, they find little evidence that it comes from a supply-side effect on economic activity. This is because economic activity as a whole has not been shown to improve due to lower taxes on the rich. They also rule out the tax avoidance channel in favor of a bargaining effect. Piketty et al (2011) model high earners as very productive workers who bargain over the surplus against firms who make zero expected profit. They allow for bargaining power to depend on bargaining effort which is incurred against a convex cost schedule. Lowering taxes on high incomes incentivizes greater bargaining effort.

Bivens and Mishel (2013), however, provide evidence that the incomes of high earners come in the form of rents derived from excess profits. We will see that in such a context, workers and firm owners are bargaining over the same pie and a tax on profits affects both sides equally; the tax drops out of the determination of their relative shares of match surplus. Nevertheless, bargaining power (as mentioned above) does matter for the incidence and general equilibrium implications of changes to the tax regime. What this paper shows is that the effects identified by Piketty et al (2011) can be generated without the requirement to endogenize the bargaining power. Moreover, the policy recommendation of raising taxes on profits for reducing the size of rents going to high earners made in Bivens and Mishel (2013) is shown only to work when it is accompanied by a commensurate reduction in the wage-tax.

Braguinsky et al (2011) use a frictionless version of the model to address the secular leftward shift in the firm size distribution in Portugal. By modelling the strong regulatory protections for labor as a tax on labor they show that the policy distorts the decision to become an entrepreneur – there are too many of them. In the absence of labor market frictions, however, the tax code does not effect vacancy creation or the relative profitability of high versus low ability entrepreneurs.

The paper also relates to the literature on tax incidence (see Fullerton and Metcalf 2002). The usual neutrality result where the economic incidence of a pay-roll tax is invariant to its legal incidence does not apply here because the tax paid by firms is not a pay-roll tax. This is why a budget balancing tax adjustment can affect the relative returns to being a worker versus an entrepreneur.

2 Model

2.1 Environment

A unit mass continuum of infinite lived risk-neutral individuals inhabits a continuous time infinite horizon economy. Individuals are characterized ex ante by their capabilities as entrepreneurs, $p \sim H$ on $[\underline{p}, \bar{p}]$. The distribution function H is assumed to be continuous. The density, $h(p)$, therefore, represents the "number" of type p individuals. There is a common discount rate, r. Individuals can choose to be either an entrepreneur or a worker.

Entrepreneurs establish firms and hire workers. They can hire any number of workers but the market is characterized by matching frictions. For the ith worker hired, the firm of type p produces $pf(k_i)$ units of the consumption good where k_i is the amount of capital rented from a perfectly competitive market to work with worker i. The individual production function $f(.)$ is increasing, concave and satisfies the Inada conditions.[3] The total output of a firm with n workers is then equal to $\sum_{i=1}^{n} pf(k_i)$ which implies constant returns to labor. To see why, notice that if $k_i = k$ for all i, the firm's output is $pf(k)n$. Moreover, when $k_i = k$, the firm's production function is equivalent to $pF(K, n)$ in which $F(.,.)$ has constant returns to scale, total capital stock, $K = nk$ and $F(k, 1) = f(k)$.

If a firm is paying worker i the wage w_i, then the entrepreneur receives income

$$y_i = (1 - \tau_f)(pf(k_i) - w_i - \rho k_i) \tag{1}$$

[3] Specifically, I require that $f(0) = 0$, $f'(0) = \infty$ and that there exists some finite value of the capital stock, k^*, such that $f'(k^*) = 1$.

where $\tau_f \in [0, 1)$ is the tax rate on profits and ρ is the user cost of capital.

The assumption that a firm's capital stock is as flexible as its workforce is contrary to what we usually assume. The focus here, however, is on steady states which are long-run outcomes. The assumption also greatly helps with the analysis. As we will see, it means that wages will be invariant to the number of workers at any particular firm.

As we will focus only on steady state and the capital market is competitive, the return on capital has to be r. The depreciation rate on capital is δ. The tax on capital income is $\tau_k \in [0, 1)$ so that $\rho(1 - \tau_k) = r + \delta$. If an individual decides to convert consumption goods into capital and rent it out there will be no effect on the present value of expected utility. Who holds capital is, therefore, moot.

Workers are those individuals who are better off entering the labor market than attempting to run a firm. Unemployed workers can direct their search according to the type, p, of the entrepreneur who runs the firm. There is, therefore, a continuum of potential markets indexed by p. Workers can freely divide their time between markets but their arrival rate of meetings with firms in any market is proportional to their presence in the market. In any market, the rate at which a wholly present worker contacts the firm is $m(\theta)$ where θ is the ratio of the number of firms to workers in the market (the market tightness). The matching function $m(.)$ is increasing, concave and satisfies the Inada conditions.[4] The rate at which a firm meets unemployed workers is, therefore, $q(\theta) \equiv m(\theta)/\theta$ which is assumed to be decreasing in θ.

Employed workers are taxed at the rate $\tau_w \in [0, 1)$ so that someone who earns wage w takes home $w(1-\tau_w)$. They also experience a flow disutility of work, $z \geq 0$. Active entrepreneurs are assumed not to experience the disutility of work. How this assumption might affect the results will be discussed below. The employment relationship is subject to breakdown. At the rate λ the firm and worker part ways and the worker becomes unemployed. The terms of trade between the firm and individual workers will be determined by generalized Nash bargaining where β will represent the bargaining power of the firm. The firm and worker bargain over the additional output provided from hiring that worker.

In this basic framework the tax rates, (τ_w, τ_k, τ_f), are exogenous. The government revenue that is obtained is thrown away. Taxes are only included to avoid repetition of the analysis when revenue is exogenous and at least

[4] Specifically, I require that $m(0) = 0$, and $m'(0) = \infty$.

one tax rate has to be endogenized to balance the budget.

2.2 Firm size

Given a market tightness, θ, let ξ_n represent the probability that the firm has $n = 0, 1, 2...$ workers. In steady state (when the ξ_ns are constant), the propensity for the firm to transition between any two levels of employment will be equalized. Thus $q(\theta)\xi_0 = \lambda\xi_1$, $q(\theta)\xi_1 = 2\lambda\xi_2$ and in general $q(\theta)\xi_n = (n+1)\lambda\xi_{n+1}$. Solving forward,

$$\xi_n = \left(\frac{q(\theta)}{\lambda}\right)^n \frac{\xi_0}{n!}.$$

Setting $\sum_n \xi_n = 1$ implies that the firm's number of workers is distributed Poisson with parameter $q(\theta)/\lambda$. Thus the matching rate of the firm, $q(\theta)$, is proportional to its expected size. The model therefore endogenously generates balanced matching as in Burdett and Vishwanath (1988)

2.3 Value functions

Let V_u be the value to being an unemployed worker (in any market) and let V_e^n be the value to being the nth worker at a firm in that market. Then,

$$rV_u = m(\theta)\mathbb{E}_n\left(V_e^n - V_u\right) \tag{2}$$

where $\mathbb{E}_n$ represents the expectation over n. And,

$$rV_e^n = w_n(1-\tau_w) - z + \lambda(V_u - V_e^n) \tag{3}$$

where w_n is the wage paid to the nth worker.

Suppressing for now, any dependence on p, let V_f^n be the value to a firm of having n employees. Then,

$$rV_f^n = q(\theta)\left(V_f^{n+1} - V_f^n\right) + n\lambda\left(V_f^{n-1} - V_f^n\right) + \sum_{i=1}^{n} y_i \quad \text{for } n = 0, 1, 2... \tag{4}$$

Let $\Delta_n^f = V_f^n - V_f^{n-1}$. So,

$$\left(r + q(\theta) + n\lambda\right)\Delta_n^f = q(\theta)\Delta_{n+1}^f + (n-1)\lambda\Delta_{n-1}^f + y_n$$

which is a second-order difference equation in Δ_n^f. Had we assumed that, like workers, entrepreneurs experience disutility of work, it would have dropped out of this expression so that Δ_n^f would not depend on z (except through y_n).[5]

If $y_n = y$ for all n, ruling out bubble (i.e. non-fundamental) paths for Δ_n^f implies

$$\Delta_n^f = \Delta^f \equiv \frac{y}{r+\lambda}. \tag{5}$$

Setting $n = 0$ in equation (4) implies that the value to starting a firm,[6]

$$V_f^0 = \frac{q(\theta)y}{r\,(r+\lambda)}. \tag{6}$$

And, the value of having n workers would be

$$V_f^n = \left(\frac{q(\theta)+nr}{r}\right)\left(\frac{y}{r+\lambda}\right).$$

2.4 Bargaining

In general, for the nth worker hired, the relevant Nash product is

$$w_n = \arg\max_w \left(\Delta_n^f\right)^\beta \left(V_e^n - V_u\right)^{1-\beta}. \tag{7}$$

From equation (3), the only source of dependence of V_e^n on n is through w_n. Similarly from equation (1), the y_ns only depend on n through the wages and capital stock. And, the capital stock only depends on n through the wages. Consequently, any solution to equation (7) will be constant with respect to n ($w_n = w$ for all n).[7] Equation (5) applies and the Nash product, (7), becomes

$$w = \arg\max_\omega \left(\frac{(1-\tau_f)\left(pf(k)-\omega-\rho k\right)}{r+\lambda}\right)^\beta \left(\frac{\omega(1-\tau_w)-z+\lambda V_u}{r+\lambda} - V_u\right)^{1-\beta}. \tag{8}$$

[5] This statement presumes that entrepreneurs would incur the same disutility of work regardless of how many workers they employ.

[6] By comparison, if firms were restricted to hire one worker (as in the standard Pissarides (2000) model) who provides the same profitability, the value to establishing a firm would be

$$\frac{q(\theta)y}{r\,(r+\lambda+q(\theta))}.$$

[7] Shimer (2006), facing a similar problem, simply asserts that constant returns to scale with respect to labor means jobs can be considered in isolation.

After substitution from equations (2) and (3), the first order condition from problem (8), which is clearly concave, implies

$$\frac{(1-\beta)(1-\tau_w)\left(pf(k)-w-\rho k\right)}{r+\lambda}=\frac{\beta\left[(1-\tau_w)\,w-z\right]}{r+\lambda+m(\theta)}. \tag{9}$$

Notice that the tax on firms, τ_f, has completely dropped out of the determination of the wage. Were z deductible from wage-taxes (or equal to zero), the wage-tax, τ_w, would have dropped out too. This reflects the ex post efficiency of the Nash bargain, anything that decreases the match surplus is felt in the same proportion by both parties. Of course τ_f still affects the value to job creation to firms and enters equation (9) indirectly through k and θ.

2.5 Capital stock per worker

As constant returns to scale with respect to labor means that jobs can be considered in isolation, the choice of how much capital to combine with any additional worker will not depend on the number of workers currently at the firm. Recall that the capital market is perfectly competitive and capital is completely fungible, this means that the firm can adjust k depending on the outcome of the bargain with the worker. For each worker hired, the type p firm solves

$$\max_k (1-\tau_f)\left(pf(k)-w-\rho k\right) \quad \text{subject to (9)}. \tag{10}$$

This formulation potentially allows for a hold-up problem which occurs whenever the firm and worker do not pre-contract on some aspect of the job. One way to avoid this would be to have the firm and worker bargain over both the wage and the capital stock. In that case, the Pareto optimality axiom of Nash bargaining would guarantee the pairwise efficient outcome. As it happens, though, the allocation here is identical to that which emerges from bargaining over both the wage and capital stock. This is because equation (9) implies

$$\frac{dw}{dk}=(1-\beta)(pf'(k)-\rho).$$

In both cases, the firm will choose k entirely to maximize the pie (which also maximizes the wage) so that the optimal choice of k solves $pf'(k)=\rho$. This choice can then be denoted by $k(p)$ where clearly $k'(p)>0$. The optimal choice of the wage, $w(p,\theta)$, then solves equation (9).

2.6 Directed Search

Unemployed workers can move freely between markets. This means that the value to unemployment will not depend on which market or markets the worker is currently searching in. Moreover, as the workers search only on the basis of the firm's type, p, the firm's choice of k and the implied value of w will be determined after the market tightness. Consequently, from equations (2) and (3), for each active firm type, $p \in P_A \subseteq [\underline{p}, \bar{p}]$, the tightness, $\theta(p)$, of its labor market will solve

$$V_u(p,\theta) \equiv \frac{m(\theta)\left[(1-\tau_w)w(p,\theta)-z\right]}{r\left(r+\lambda+m(\theta)\right)} = \bar{V}_u. \tag{11}$$

Where $\bar{V}_u$ is the common value to unemployment which will depend on the set of active firms, P_A.

Then, from equation (6) the value to establishing a type p firm is

$$V_f^0(p) \equiv \frac{q(\theta(p))(1-\tau_f)\left[pf(k(p)) - w(p,\theta(p)) - \rho k(p)\right]}{r\left(r+\lambda\right)}. \tag{12}$$

2.7 Comparative statics in p

At any productivity level (after dropping dependence on n) differencing equations (2) and (3) obtains

$$(r+\lambda)\frac{V_e - V_u}{(1-\tau_w)} = w - \frac{z + rV_u}{(1-\tau_w)}. \tag{13}$$

Meanwhile, substituting from equation (1) into (5) yields

$$(r+\lambda)\frac{\Delta^f}{(1-\tau_f)} = pf(k) - w - \rho k.$$

Adding these to eliminate the wage and using equation (11), implies that we can express the match surplus as

$$S(p) \equiv (r+\lambda)\left[\frac{V_e - V_u}{(1-\tau_w)} + \frac{\Delta^f}{(1-\tau_f)}\right] = pf(k(p)) - \rho k(p) - \frac{z + r\bar{V}_u}{(1-\tau_w)}.$$

Thus, for any given value of $\bar{V}_u$ such that $S(\bar{p}) > 0$, the set P_A is non-empty and $S(p)$ is strictly increasing in p.

It follows from equations (2) and (9) that

$$r\bar{V}_u = \frac{m(\theta(p))(1-\beta)(1-\tau_w)S(p)}{(r+\lambda)}$$

so $\theta(p)$ is strictly decreasing; more productive firms operate in more favorable labor markets. Then, from equation (13),

$$w(p,\theta(p)) = (1-\beta)(1-\tau_w)S(p) + \frac{z + r\bar{V}_u}{(1-\tau_w)}$$

which is strictly increasing in p. More productive firms pay higher wages than less productive firms which compensates the workers for the lower matching rates they face. And, as

$$rV_f^0(p) = \frac{q(\theta(p))\beta(1-\tau_f)S(p)}{(r+\lambda)},$$

$V_f^0(p)$ is strictly increasing in p. So, there exists a unique threshold value of entrepreneurial ability, $\tilde{p}$, such that $V_f^0(\tilde{p}) = \bar{V}_u$. Individuals with p at or above $\tilde{p}$ choose to set up firms and those with p below $\tilde{p}$ remain as workers.

2.8 Steady State

Let $e(p)$ be the population of workers employed at type p firms and let $u(p)$ be the population of workers looking for employment at type p firms. Then the total population of workers associated with market p is $j(p) = e(p) + u(p)$. In what follows I will refer to $j(p)$ as the workforce at p. Then, the total workforce is given by[8]

$$J(\tilde{p}) = \int_{\tilde{p}}^{\bar{p}} j(p)dp.$$

In steady state, the flow into and out from employment in market p are equal so that $m(\theta(p))u(p) = \lambda e(p)$. Thus,

$$j(p) = \frac{\lambda + m(\theta(p))}{\lambda} u(p).$$

As there are $h(p)$ firms in market p, $\theta(p) = h(p)/u(p)$ which means that

$$j(p) = \frac{[\lambda + m(\theta(p))]\, h(p)}{\lambda\theta(p)}.$$

[8] Technically, the workforce here is 1 because entrepreneurs should also be included in it. So, $J(\tilde{p})$ is really the "force of workers".

2.9 Equilibrium

Definition 1 *A steady state directed search equilibrium is a threshold value of entrepreneurial ability, $\tilde{p}$, and a market tightness function $\tilde{\theta}(p)$ such that:*

1. *All individuals with $p < \tilde{p}$ are workers while those with $p \geq \tilde{p}$ are entrepreneurs*

2. *Type $\tilde{p}$ individuals are indifferent between being a worker and entrepreneurship: $V_f^0(\tilde{p}) = \bar{V}_u$.*

3. *Unemployed workers are indifferent across markets: $V_u(p, \tilde{\theta}(p)) = \bar{V}_u$ for all $p \geq \tilde{p}$*

4. *The population of workers equals the labor force: $H(\tilde{p}) = J(\tilde{p})$*

To characterize equilibrium, I first simplify the notation by defining $X(p) \equiv pf(k(p)) - \rho k(p)$. $X(p)$ is, therefore, the net-of-capital-cost flow match output. Solving (9) for the wage yields

$$w = \frac{(r + \lambda + m(\theta))(1-\beta)(1-\tau_w)X(p) + (r+\lambda)\beta z}{(1-\tau_w)[r + \lambda + (1-\beta)m(\theta)]}.$$

The wage is an average of the net match output and disutility of work weighted by the respective bargaining powers of the worker and firm.

Substituting into equations (11) and (12) respectively imply the value to unemployment in market (p, θ) is

$$V_u(p, \theta) = \frac{m(\theta)(1-\beta)[(1-\tau_w)X(p) - z]}{r[r + \lambda + (1-\beta)m(\theta)]} \tag{14}$$

and the value to becoming a type p entrepreneur is

$$V_f^0(p) = \frac{m(\theta)\beta(1-\tau_f)[(1-\tau_w)X(p) - z]}{\theta r(1-\tau_w)[r + \lambda + (1-\beta)m(\theta)]}. \tag{15}$$

Now for any proposed value, $\tilde{p}$, of p at which individuals are indifferent as to their career choice $V_u(\tilde{p}, \theta) = V_f^0(\tilde{p})$. Equating implies a unique value, $\tilde{\theta} = \tilde{\theta}(\tilde{p})$, of the market tightness such that

$$\tilde{\theta} = \frac{\beta(1-\tau_f)}{(1-\beta)(1-\tau_w)}. \tag{16}$$

So, $\tilde{\theta}$ is invariant to many features of the environment (e.g. the distribution function, $H(.)$ and the functional forms of $f(.)$ and $m(.)$). It is simply the ratio of the tax adjusted respective bargaining powers of firms and workers. At $p = \tilde{p}$, workers are indifferent between becoming an entrepreneur or remaining a worker. Moreover, for the marginal entrepreneur, there are no excess profits – they split the net of tax and disutility of work output according to their bargaining powers. The ratio of their matching rates, $\tilde{\theta}$, then equates the returns to either career choice.

Now, for any given $\tilde{p}$, the value to unemployment required of workers in any active market, $\bar{V}_u = V_u(\tilde{p}, \tilde{\theta})$. The equilibrium market tightness function, $\tilde{\theta}(p)$ is, then, obtained from Clause 3 of Definition 1: $\bar{V}_u = V_u(p, \tilde{\theta}(p))$. To pin down the equilibrium value of $\tilde{p}$ we use Clause 4 of Definition 1. After substituting for $j(p)$ it becomes,

$$H(\tilde{p}) = \int_{\tilde{p}}^{\bar{p}} \left(\frac{\lambda + m(\tilde{\theta}(p))}{\lambda \tilde{\theta}(p)} \right) dH(p). \tag{17}$$

Proposition 2 *Equilibrium exists and is unique*

Proof. See Appendix ■

2.10 Comparison with frictionless model.

Braguinsky et al (2011) explore a similar but frictionless model. Here I will use the comparison of the two frameworks to provide a basis for understanding the phenomena of interest: how the tax code affects vacancy creation and the relative incomes of the higher ability entrepreneurs.

Given the constant returns to scale with respect to employment, allowing matching to occur infinitely quickly in my framework will mean $\tilde{p} \to \bar{p}$. There will be a single type of firm in the economy for which everyone else works. To maintain an interior solution for $\tilde{p}$, Braguinsky et al (2011) incorporate decreasing returns to scale with respect to employment. Translated into my notation, their firms each have a production function, pn^{ψ}, where n is the number of workers and $0 < \psi < 1$. With a competitive labor market, workers all get the same wage, w. The profitability of the type p firm is

$$\pi(p) = (1 - \tau_f) p^{\frac{1}{1-\psi}} w^{-\frac{\psi}{1-\psi}} C$$

where C is a function only of parameters. So,

$$\frac{\pi(\hat{p})}{\pi(p)} = \left(\frac{\hat{p}}{p}\right)^{\frac{1}{1-\psi}}. \tag{18}$$

A point to note here is that introducing a value of leisure or a disutility from work will affect w and $\tilde{p}$ but the profit function does not change. So, Even with $z > 0$, in the the frictionless model, the ratio of earnings of high versus low ability entrepreneurs is invariant to the tax code. Given the absence of unemployment, the frictionless model cannot say anything about vacancy creation.

In the current framework, from equation (15) for any two ability levels p and $\hat{p}$ above $\tilde{p}$,

$$\frac{V_f^0(\hat{p})}{V_f^0(p)} = \frac{m(\tilde{\theta}(\hat{p}))[(1-\tau_w)X(\hat{p}) - z]\tilde{\theta}(p)[r + \lambda + (1-\beta)m(\tilde{\theta}(p))]}{m(\tilde{\theta}(p))[(1-\tau_w)X(p) - z]\tilde{\theta}(\hat{p})[r + \lambda + (1-\beta)m(\tilde{\theta}(\hat{p}))]}. \tag{19}$$

Now, given that $V_u(p, \tilde{\theta}(p)) = \bar{V}_u$ for all p, equation (14) means that this ratio reduces to

$$\frac{V_f^0(\hat{p})}{V_f^0(p)} = \frac{\tilde{\theta}(p)}{\tilde{\theta}(\hat{p})}. \tag{20}$$

The relative value to market entry for entrepreneurs is the inverse ratio of the tightness of the markets they face. From equation (14),

$$\frac{m(\tilde{\theta}(p))}{m(\tilde{\theta}(\hat{p}))} = \frac{(1-\tau_w)X(\hat{p}) - z - r\bar{V}_u}{(1-\tau_w)X(p) - z - r\bar{V}_u}. \tag{21}$$

We would like to know when and how a change in the tax code can favor the higher ability entrepreneurs over their lower ability counterparts. From equation (21), were $z + r\bar{V}_u = 0$ the tax code would have no effect on the ratio in equation (20) (as in the frictionless model). Now it is straightforward to show that the sign of the derivative of the RHS of equation (21) with respect to τ_w is the same as that of the expression

$$[X(\hat{p}) - X(p)]\left[z + r\bar{V}_u + r(1-\tau_w)\frac{d\bar{V}_u}{d\tau_w}\right]. \tag{22}$$

The sensitivity of $\bar{V}_u$ to τ_w depends on the the bargaining power, β. When $\beta = 1$, the wage is simply $z/(1-\tau_w)$. Then $\bar{V}_u = 0$ and is invariant to

τ_w. The expression (22) is, then, clearly positive which means an increase in τ_w benefits the high ability entrepreneurs at the expense of the lower ability ones. This result is at least suggestive of the result (verified below for specific parameter values) that higher β implies a greater benefit to high income individuals of an increase in the tax on wages.

2.11 Efficiency

Because all participants are risk neutral, at any point in time, t, welfare in the economy, $W(t)$, is simply output minus costs. If $G(t)$ is time t government spending,

$$W(t) = \int_{\tilde{p}(t)}^{\bar{p}} \left(pf(k(p,t)) - \delta k(p,t) - z\right) e(p,t)dp - G(t)$$

where $e(p,t)$ is the measure of workers employed at type p firms at time t, $k(p,t)$ is the per worker capital stock at firm type p at time t and $\tilde{p}(t)$ is the cut-off value of entrepreneurial ability at time t. A Social planner then solves the problem,

$$\begin{aligned} & \max_{k(p,t),\theta(p,t),\tilde{p}(t)} \int_0^\infty e^{-rt} W(t)dt \\ \text{subject to } H(\tilde{p}(t)) &= J(\tilde{p}(t)) \text{ and the law of motion for } e(p,t). \end{aligned}$$

This is a very complicated problem in the current environment because there will be differential flows of workers in and out of each market as $\tilde{p}(t)$ changes.

A simpler problem is to focus on steady states and constant government spending. Without discounting, this amounts to

$$\max_{k(p),\theta(p),\tilde{p}} \int_{\tilde{p}}^{\bar{p}} (X(p) - z) \frac{m(\theta(p))}{\lambda\theta(p)} dH(p) - G$$
$$\text{subject to } H(\tilde{p}) = \int_{\tilde{p}}^{\bar{p}} \left(\frac{\lambda + m(\theta(p))}{\lambda\theta(p)} \right) dH(p)$$

where $X(p) = f(k(p)) - \delta k(p)$. Letting μ be the co-state variable on the population constraint, the first-order condition with respect to $\tilde{p}$ implies

$$\mu = \frac{(X(\tilde{p}_p) - z)m(\theta_p(\tilde{p}_p))}{\lambda(1 + \theta_p(\tilde{p}_p)) + m(\theta_p(\tilde{p}_p))} \tag{23}$$

where $\tilde{p}_p$ is the Planner's steady state value of $\tilde{p}$ and $\theta_p(.)$ is the Planner's steady state market tightness function. The optimality condition for market tightness implies that $\theta_p(.)$ solves

$$\frac{(X(p)-z)m(\theta_p(p))\left[1-\eta(\theta_p(p))\right]}{\lambda+m(\theta_p(p))\left[1-\eta(\theta_p(p))\right]}=\mu \tag{24}$$

where $\eta(.)$ is the elasticity of $m(.)$.

So, given $\tilde{p}_p$, eliminating μ from equations (23) and (24) implies

$$\tilde{\theta}_p=\frac{\tilde{\eta}_p}{1-\tilde{\eta}_p} \tag{25}$$

where $\tilde{\theta}_p=\theta_p(\tilde{p}_p)$ and $\tilde{\eta}_p=\eta(\tilde{\theta}_p)$. Then, $\tilde{p}_p$ solves $H(\tilde{p}_p)=J(\tilde{p}_p)$.

Without any further restrictions on $m(.)$ equation (25) may not uniquely pin down $\tilde{\theta}_p$. But, at any interior solution to the Planner's problem, these optimality conditions must hold. So we can still ask under what circumstances does the market economy outcome coincide with that of the Planner's solution? If $\tilde{\eta}_p$ from the Planner's solution is equal to the firm's bargaining power, β, and $\tau_w=\tau_f$, the market economy will choose $\tilde{\theta}$ optimally. Furthermore, if $\tau_w=0$, $\mu=r\bar{V}_u$.[9] The value to being unemployed in the market economy is equal to the shadow price on the population constraint. Moreover, if $m(.)$ is isoelastic with $\eta=\beta$, equation (24) implies that the Planner's solution is unique and $\tilde{\theta}(p)$ is efficient for all p. This is a generalization of the Hosios (1990) condition into this environment. If the elasticity of the matching function equals the bargaining power of the firms, the private and social return to becoming an entrepreneur are equalized.

A natural further question is whether or not the simple linear tax code employed here can implement the constrained efficient outcome. Although tax rates can be chosen to satisfy equation (25), inspection of equations (14)

[9] Recognizing that the denominators in both (23) and (24) are effective discount rates, adding Planner discounting back in means these expressions become respectively

$$\mu=\frac{(X(\tilde{p}_p)-z)m(\theta_p(\tilde{p}_p))}{(r+\lambda)(1+\theta_p(\tilde{p}_p))+m(\theta_p(\tilde{p}_p))}$$

and

$$\frac{(X(p)-z)m(\theta_p(p))\left[1-\eta(\theta_p(p))\right]}{r+\lambda+m(\theta_p(p))\left[1-\eta(\theta_p(p))\right]}=\mu.$$

Equation (25) is unchanged.

and (24) provides a negative answer in general.[10] The fundamental tension in the model is that entrepreneurial ability is innate. As such, the rents it generates should be taxed first. However, the extensive margin decision means that entrepreneurship is not completely inelastic. With $\beta = \eta$ equalizing the tax rates causes efficient occupational choice even when there is misallocation of workers to markets.

3 Simulations

While the model behaves quite predictably at any given value of p, because the impact of the tax code is potentially felt differentially in different markets, it is necessary to resort to numerical analysis for the main results of the paper. Given the level of abstractness of the framework, however, these should be viewed as comparative statics which demonstrate the workings of the model rather than as quantitative predictions.

3.1 Government spending and its relationship to theory

In the preceding analysis, the tax code has been kept exogenous. This simplifies the algebra and leads to a unique equilibrium. In the numerical analysis, taxes will be chosen to generate a given level of government spending. The essential theory under such exercises remains intact (see Albrecht and Vroman 2005 and Coles and Masters 2007). Due to the existence of Laffer curves in tax rates, however, there are typically either zero or two values of the tax rate that can support a given amount of tax revenues. I will focus on equilibria that are on the "good" side of the Laffer curve in that the tax rates are low and the economic activity is high.

The government is assumed to balance its budget at all times. Its revenue, is given by

$$\int_{\tilde{p}}^{\bar{p}} \left\{ \left[pf(k(p)) - w(p,\theta(p)) - \rho k(p) \right] \tau_f + \rho k(p) \tau_k + w(p,\theta(p)) \tau_w \right\} e(p) dp.$$

The first term in the curly brackets is the income from corporate taxes on profits per worker. The profits are net of capital-taxes. The second term is

[10] As workers cannot deduct their disutility of work, even when $\eta = \beta$ and $\tau_w = \tau_f$ (with $\tau_k = 0$) the allocation is not constrained efficient unless $z = 0$.

the income from the tax per worker on capital and the final term is the tax on wages. Government expenditures, G, are thrown away. Substituting for $e(p)$ and equating leads to the government budget constraint:

$$\int_{\tilde{p}}^{\bar{p}} \{pf(k(p))\tau_f + \rho k(p)(\tau_k - \tau_f) + w(p, \theta(p))(\tau_w - \tau_f)\} \frac{m(\theta(p))h(p)}{\lambda\theta(p)} dp = G. \tag{26}$$

3.2 Functional forms

The production function operated by each entrepreneur is assumed to be Cobb-Douglas so that output per worker at the firm operated by an owner with ability level p is pk^{ϕ}. The matching function is also assumed to be Cobb-Douglas so that $m(\theta) = \bar{m}\theta^{\eta}$ and $q(\theta) = \bar{m}\theta^{\eta-1}$. A further, less usual, functional form to choose is that of the ex ante distribution of entrepreneurial ability, $H(p)$. An issue here is that much of the distribution is not active in equilibrium. For this reason it makes sense to use a functional form that is robust to truncation. One such distribution that is commonly used in the literature on firm size distributions (see Helpman et al 2010) is the Pareto. The general form implies

$$H(p) = 1 - \left(\frac{\underline{p}}{p}\right)^{\sigma}$$

where $\underline{p}$ is both the infimum to the support of $H(.)$ and a scale parameter. The parameter σ is called the shape parameter. The distribution of abilities among those who choose entrepreneurship (i.e. those with $p \geq \tilde{p}$) is then

$$\tilde{H}(p) = 1 - \left(\frac{\tilde{p}}{p}\right)^{\sigma}.$$

So that the truncated distribution retains the same shape parameter as the original distribution.

3.3 Parameters

The model parameters fall into three groups: those that are obtained from outside sources, those that are subject to a normalization and those that are chosen to bring the model in line with quantitative targets. The time unit is one year so r is set to 0.04 which is standard in the macro literature. Setting $\lambda = 0.2$ comes from Cole and Rogerson (1999) and is similar to other figures used in the DMP literature. It implies an average match duration of 5 years. Petrongolo and Pissarides (2001) and Blanchard and Diamond (1989) provide estimates of matching function parameters. From there I set $\eta = 0.5$. The consensus on the size of $\bar{m}$ is that it should be about 1 for monthly data which would suggest a value of around 12 for a time unit of 1 year. However, here the firms are always in the labor market so the appropriate measure of vacancies is less obvious. Consequently, $\bar{m}$ will be chosen to meet the quantitative targets. From the real business cycle literature, the index on capital in the production function, ϕ, is set to 0.33 and the depreciation rate, δ, was set to 0.1.

The value of β, the firms' bargaining power is 0.96. With the advent of matched firm/worker panel data, there have been a number of empirical studies which attempt to measure the extent to which variations in match surplus translate into variations in wages. Card et al (2014) provide their own estimates of the elasticity of the wage with respect to "quasi-rents". Their own estimates in the range 0.04 to 0.05 imply, in their framework, a range for the worker's bargaining power of 0.03 to 0.04. They cite a large number of studies which have come up with similar figures and some for which the estimates are somewhat larger. This issue will be revisited below.

The numerical results are unaffected by a change in $\underline{p}$, the scale parameter on the ex ante distribution of entrepreneurial ability, that is accompanied by an appropriate adjustment in z, the disutility of work – $\underline{p}$ was normalized to 1. The shape parameter, σ, was chosen to meet the quantitative targets. Based on the maximum qualified dividend tax rate in the USA between 2003 and 2012, the tax on firms, τ_f, is set to 15%.

The quantitative targets are an unemployment rate of 6%, a share of entrepreneurs in the economy at 5%[11], a share of government spending at 18.6% of GDP and a share of before-tax income going to the top 1% of earners at 20%. It takes 4 parameters to meet these targets: $\bar{m}$, z, σ and τ_w.[12] Table 1 summarizes the parameters for the leading example.

[11] According to the US Census Bureau, in 2008 the total number of employees at "employee firms" is close to 20 times the number of such firms.

[12] The numerical solution method proceeds by picking an initial guess at $\tilde{p}$. Based on this it obtains $\tilde{\theta}$ from equation (16) and $\bar{V}_u$ from equation (14). The program divides up the remaining range for $H(p)$ (i.e. from $H(\tilde{p})$ to 1) into 5,000 subintervals and calculates,

r	λ	δ	$\bar{m}$	η	ϕ	β	z	$\underline{p}$	σ	τ_f	τ_w
0.04	0.2	0.1	4.52	0.5	0.33	0.96	0.748	1	7.65	0.15	0.355

Table 1: Parameter values for the leading example

3.4 Experiment

The primary experiment is to impose a common value for τ_f and τ_w that maintains the same amount of government revenue (i.e. $G = 0.6939$). We will then see how this affects job creation and the income shares of various percentiles of the population in terms of pre- and post-tax earnings. The common tax rate that achieves this is 28.3%. To isolate the effects of each tax change, results for the incremental imposition of each will be reported. For a benchmark comparison, I also provide a set of results for the Planner's economy. To implement this in the model, I set $\tau_w = \tau_f = 0$ and set the bargaining power of the firms equal to the elasticity of the matching function with respect to the labor market tightness ($\beta = \eta$).

Metric	Equal tax	Lower τ_f	Unequal tax	Efficient outcome
Unemployment (%)	5.38	5.32	6.00	27.57
GDP	3.660	3.649	3.731	4.404
Welfare	1.090	(1.209)	1.140	2.414
% Entrepreneurs	5.29	5.45	5.00	0.71
Entrepreneurs' share (%)	25.67	25.54	25.27	-
1% share (%)	19.49	19.40	20.00	-
0.1% share (%)	8.01	7.96	8.45	-
0.01% share (%)	2.14	2.17	2.38	-
0.002% income	1,684	1,653	1,895	-
Average worker wage	1.693	1.696	1.749	-
Mm ratio	1.023	1.023	1.023	-

Table 2: Results (tax on profits)

p, $k(p)$, $X(p)$ and solves for $\theta(p)$ from $V_u(p, \theta) = \bar{V}_u$. It then integrates RHS of equation (17) to obtain the measure of workers and compares it to $H(\tilde{p})$, the number of people not choosing to be entrepreneurs implied by the guess on $\tilde{p}$. Depending on the discrepancy in equation (17) a new value of $\tilde{p}$ is chosen by a simple step method. The system repeats until the discrepancy is less than 0.00001. Convergence usually occurs within 20 iterations.

The above calculation was embedded in a minimization algorithm to obtain the parameter values required to match the outcomes to their quantitative target values.

Table 2 summarizes the main findings. The columns refer to the tax regimes and the efficient outcome. The column headed "lower τ_f" means that $\tau_w = 28.3\%$ while $\tau_f = 0.15$ which imply a government deficit at 3.45% of GDP. The welfare measure in that column is reported in parentheses because it is not comparable to the other measures where the full expense of government spending is factored in.

Many of the row headings are largely self-explanatory. The "x-share" rows refer to the share of national (before-tax) income going to the top x percent and above of earners. The "0.002% income" are the taxable earnings of the individuals in the 0.002% percentile (i.e. those who are one in 50,000 earners in the whole economy). The "Average worker wage" is the mean before-tax wage among those who chose not to become entrepreneurs.[13] The model cannot simultaneously match the income and firm size distributions. This is because in the data, large firms have many high earning individuals. For this paper, what matters is that the earnings of those individuals are tied to the profitability of the firm. The row headed "Mm ratio" provides the mean to minimum wage ratio measure of workers' wage dispersion as introduced by Hornstein et al (2011).

Consistent with the empirical findings of Piketty et al (2011), there is little impact of the combined tax change on GDP. Lowering the tax on profits alone increases the returns to entrepreneurship which inflates their number. The drop in unemployment comes entirely from the shift in occupations. Before-tax incomes drop for entrepreneurs because there are fewer workers to go around. Inequality drops here too. These results support the conservative political position that a cut to the tax rate on the rich will increase vacancy creation. It also perhaps points to their underlying assumption that rather than restore budget balance by raising taxes elsewhere, G should simply fall.

The typical exercise that is carried out in economics, however, is to separate revenue from expenditure. When the wage-tax rises to balance the budget, the before-tax wage rises and there is a net loss of firms as compared to the equal tax regime. The sequential nature of search means that there is a low degree of wage dispersion both before and after the tax change. For low ability entrepreneurs, the wage they pay the workers is a larger share of the total match output than it is for the high ability entrepreneurs. Any

[13] The mean annual income for single tax filers in the USA in 2011 was around \$26k. Here the highest earners make around 900 times as much which translates into \$26M of whom there would be around 4000 adults in the USA.

increase in wages disproportionately affects the smaller firms and squeezes the smallest out of the market. With $\beta = 0.96$, firms pick up a large part of the increased tax burden. The wage-tax increase acts like a barrier to entry which benefits the larger firms at the expense of the smaller ones. Inequality becomes more pronounced.

The distorting effect of unequal taxes on the size of firms causes job creation to be worse than when taxes are equalized. To see why, we need to think about how matching occurs in the markets. The average unemployment rate faced by firms under both the equal and unequal tax regime is 3.3%. Why does this differ from the values reported in the table? Because the distribution of entrepreneurial abilities is downward sloping, there are more firms with low values of p. They operate in markets with low rates of unemployment, $u(p)/j(p)$. Now, when a change in the tax regime from equal to unequal pushes all wages upwards, the degree of heterogeneity across markets increases, and unemployment is higher. Notice, however, that welfare improves. This is because there is a misallocation of workers across markets. The Planner would allocate even more workers to the high p markets. This issue will be revisited below.

As mentioned above, Card et al (2014) obtain values for the elasticity of the wage with respect to the match surplus of between 0.04 and 0.05. They also cite a large number of other studies using matched panel data that typically find even lower numbers. A comparable figure from the model, can be obtained from

$$\beta S(p) = (1 - \tau_w) w(p, \tilde{\theta}(p)) - z - r\bar{V}_u$$

where $S(p)$ is match surplus in market p. Then the elasticity of the wage with respect to the match surplus is

$$\left(\frac{dw}{dS}\right)\left(\frac{S}{w}\right) = \frac{(1 - \tau_w) w(p, \tilde{\theta}(p)) - z - r\bar{V}_u}{(1 - \tau_w) w(p, \tilde{\theta}(p))}.$$

At the median wage, under the unequal tax regime, this figure is 1.82%. Card et al (2014) do refer to other older studies for which this figure is closer to 25%. They point out that those studies either consider very large or unionized firms. Under the current parameterization this elasticity for the largest firms is 15.7%.

3.5 Capital-tax

The preceding analysis focuses on the tax paid on the profits received by the owners of firms. The tax on capital, τ_k, was kept at zero. Even though most tax systems allow for the cost of capital to be deducted before tax, there is a perception that the relevant taxation for investment and job creation should be one that drives a wedge between the return on capital and its societal cost (see for example Abel, Bernanke and Croushore 2013 p.127). In this model, that would best be represented by τ_k. To follow up on this, a second experiment was conducted. First, τ_k was set at 15%, τ_f was set to zero and the tax on wages, τ_w, was chosen to cover the same expenditure, 0.6939, as in the tax on profits experiment. The value of τ_w required to bring about budget balance in this case is 35.39%. Then, a common value of τ_k and τ_w was chosen to, once again, generate the same government revenue. This common tax rate is $\tau_k = \tau_w = 28.89\%$. The results appear in Table 3.

Metric	Equal tax	Unequal tax
Unemployment (%)	6.60	6.65
GDP	3.208	3.506
Welfare	0.791	0.992
% Entrepreneurs	4.65	4.66
Entrepreneurs' share (%)	25.12	25.06
1% share (%)	20.46	20.49
0.1% share (%)	8.80	8.85
0.01% share (%)	2.27	2.28
0.002% income	1,787	1,963
Average worker wage	1.514	1.658

Table 3: Results (capital-tax)

Now there is a significant impact on GDP but the before-tax shares of income going to the top percentiles do not change very much. The share of before-tax income going to capital is always equal to ϕ, the elasticity of output with respect to capital. As the tax on capital falls, the returns increase which increases investment along with GDP. The increased investment impacts everyone's before-tax income similarly – it rises by about 9.6% across the board. Welfare increases by 25%.

3.6 An alternative parameterization

While the results in Table 2 imply that, at the given parameter values, a balanced budget switch to lower profit-taxes reduces vacancy creation and increases income dispersion, a goal of the paper is to understand the robustness of these effects. Given the high level of unemployment associated with the efficient allocation in Table 2 it is reasonable to ask what the predictions of the model are when the laissez-faire economy is calibrated to coincide with the efficient allocation. This means setting $\beta = \eta$ and seeing how close to the empirical targets we can get.

With such a low value for β, however, the model, with non-negative values of z, can no longer simultaneously meet all of the empirical targets. Setting z to zero means dropping one target. The one chosen is that the top 1% of the population should earn 20% of the income. Although key to the debate on inequality it does not play a major role in addressing the impact of the tax code on relative earnings. The remaining targets, 5% entrepreneurs, 6% unemployment and 18.6% of GDP going to government spending, remain intact. The parameter values required to hit these targets are provided in Table 4. All other parameters remain as in Table 1. Balancing the budget now requires that $G = 0.2763$.

$\bar{m}$	β	z	σ	τ_f	τ_w
3.3	0.5	0	69.4	0.15	0.287

Table 4: Parameter values for the alternative example

Metric	Equal tax	Lower τ_f	Unequal tax
Unemployment (%)	6.46	6.05	6.01
GDP	1.486	1.486	1.486
Welfare	0.720	(0.728)	0.719
% Entrepreneurs	4.60	4.94	4.97
Entrepreneurs' share (%)	4.97	4.69	4.67
1% share (%)	1.621	1.482	1.472
0.1% share (%)	0.267	0.248	0.248
0.01% share (%)	0.040	0.036	0.036
0.002% income	7.634	7.149	7.112
Average worker wage	1.037	1.040	1.040
Mm ratio	1.0135	1.0135	1.0135

Table 5 Results for tax on profits in $\beta = \eta$ parameterization

The results appear in Table 5. The equalized tax rate that generates the same revenue is 27.8%. With $z = 0$ and $\beta = \eta$ the equal tax regime implements the constrained efficient allocation so the fourth column of Table 5 is omitted. At these parameters, the results for the balanced budget effect are almost all reversed. Because entrepreneurs receive less than 5% of income, equalizing the tax rates involves a much bigger change in the tax rate on profits than it does in the tax rate on wages. Qualitatively, the effect of the profit-tax cut taken alone is the same as before. Here, though, the wage-tax increase has different effects from Table 2. It tends to reinforce the effects of lowering τ_f.

So the main difference between the Table 2 and Table 5 results is the size and impact of the change in τ_w on the before-tax wage. The difference in size of the wage-tax effect comes from the fact that, under the Hosios condition, entrepreneurs' share of income is so much lower. To see why the effects are also qualitatively different, consider what happens if firms have all of the bargaining power. Then, $w(1 - \tau_w) = z$ for all p and an increase in the tax on wages is fully absorbed by the firms in the form of a wage increase. This reduces the return to being the marginal entrepreneur. The set of firms shrinks while the sizes of those that remain increase. When firms have lower bargaining power (as in Table 5), workers pick up some of the increased tax burden. This increases the relative return to entrepreneurship and employment rises. For lower values of the firms' bargaining power then, the wage-tax acts like a subsidy to entrepreneurship. This is consistent with the results of Braguinsky et al (2011) who find that making labor hiring expensive causes there to be too many firms. As their model is frictionless, it most closely aligns to the Hosios condition parameterization of my model.

The low degree of wage dispersion in both parameterizations occurs because of the sequential nature of search and because the unemployment rate is low. No one will enter a market where there is a low wage even with a very high chance of getting a job when a market offering a much higher wage with a reasonable expected wait time is available. But, with $\beta = 0.96$, this leads to a considerable amount of misallocation of workers across markets. To see this, consider what happens if we impose the Hosios Rule, $\beta = 0.5$, with the Table 1 parameters and an equal tax to balance the budget (i.e. $\tau_w = \tau_f = 0.2037$). As the unemployment rate is then 30.53% and welfare is 1.415, the allocation is close to the constrained efficient one. The Mm ratio is 1.281. This demonstrates the trade-off between unemployment and misallocation of workers across markets.

4 Conclusion

This paper presents a framework for simultaneously considering the role of the tax code in the determination of vacancy creation and income inequality. A cut in the tax on profits taken in isolation is shown to boost vacancy creation and reduce before-tax income inequality. The impact of the budget-balancing increase in the wage-tax depends on the parameterization. When, as suggested by the empirical literature, the firms' bargaining power is high, the increased wage-tax is almost entirely borne by the firms. In that case the set of active firms shrinks. The implied reduction in vacancy creation and increase in inequality outweigh the effects of the initial cut in profit-taxes. When this happens, job creation declines and the before-tax income share going to the very rich increases. When parameters are chosen to implement the constrained efficient allocation, the implied bargaining power of firms is much lower. In that case, workers bear more of the increased tax and the return to entrepreneurship increases – the impact of the profit-tax reduction is strengthened. A tax on capital, meanwhile, is shown to be a bad idea. It increases the user cost of capital and leaves everyone worse-off.

The implications of this analysis for real world policy makers are mixed. Unfortunately there is still some debate about the appropriate value for the bargaining power in employment relationships. If the model is taken seriously, however, getting close to the earning power of the highest income individuals requires that entrepreneurs have high bargaining power with respect to their employees. Then, when accompanied by a decrease in the tax on wages, the raising of taxes on entrepreneurial rents can increase vacancy creation and reduce inequality. A caveat is that it may be difficult in practice to distinguish entrepreneurial rents from returns on capital. Dividends paid on equity issued to generate funds used to acquire plant and equipment should be viewed as a return on capital. Dividends paid on equity retained by the original owner represent entrepreneurial rents. Devising a scheme to distinguish these income sources is left for future work.

5 Appendix

5.1 Proof of Proposition 2

As $H(p)$ is continuous, the left hand side (LHS) of equation (17) is strictly increasing in $\tilde{p}$. Differentiating RHS of (17) yields,

$$\frac{d}{d\tilde{p}}\int_{\tilde{p}}^{\bar{p}}\left(\frac{\lambda+m(\tilde{\theta}(p))}{\lambda\tilde{\theta}(p)}\right)dH(p)=-\left(\frac{\lambda+m(\tilde{\theta})}{\lambda\tilde{\theta}}\right)h(\tilde{p})$$
$$-\int_{\tilde{p}}^{\bar{p}}\left(\frac{\lambda+m(\tilde{\theta}(p))-\tilde{\theta}(p)m(\tilde{\theta}(p))}{\left[\tilde{\theta}(p)\right]^2}\right)\frac{d\tilde{\theta}(p)}{d\tilde{p}}dH(p). \quad (27)$$

The second term reflects the fact that the function $\tilde{\theta}(p)$ is parameterized by $\tilde{p}$. (Actually, the preceding analysis implies that $\tilde{\theta}(p)$ is parameterized by $\bar{V}_u$. But, as $\bar{V}_u = V_u(\tilde{p}, \tilde{\theta})$, (14) with (16) specify a one-to-one correspondence between $\tilde{p}$ and $\bar{V}_u$.) From the assumptions made on the matching function, the term in parentheses within the last integral in (27) is always positive. We need to obtain the sign of the derivative $\frac{d\tilde{\theta}(p)}{d\tilde{p}}$.

First notice that $\tilde{\theta}(\tilde{p}) = \tilde{\theta}$ as given by (16) which does not change with $\tilde{p}$. From (14) then, for $\tilde{p}$ to rise requires that $V_u(\tilde{p}, \tilde{\theta})$ has to to rise which means that $\bar{V}_u$ has to rise. Now for any given value of p, $\tilde{\theta}(p)$ solves $V_u(p,\theta) = \bar{V}_u$. From (14) an increase in $\bar{V}_u$ for a given value of p means θ has to rise. Thus $\tilde{\theta}(p)$ shifts upwards when $\tilde{p}$ increases. Substituting this result into (27) implies that the right hand side (RHS) of (17) is decreasing in $\tilde{p}$. Any solution, $\tilde{p}$, to (17) must be unique.

It is still required to show that a solution exists. First consider $\tilde{p}$ close to $\underline{p}$: $H(\underline{p}) = 0$ and $\lim_{\tilde{p}\to\underline{p}}$RHS(17)$> 0$. Now consider $\tilde{p}$ close to $\bar{p}$: $\lim_{\tilde{p}\to\bar{p}} H(\tilde{p}) = 1$ while $\lim_{\tilde{p}\to\bar{p}}$RHS(17)$= 0$.

6 References

Abel, A., B. Bernanke and D. Croushore (2013) *Macroeconomics (8th Edition)* New York: Pearson.

Acemoglu, D. and W. Hawkins (2014) "Search with Multi-worker Firms" *Theoretical Economics* **9:** 583-628.

Albrecht, J. and S. Vroman (2005) "Equilibrium Search with Time-Varying Unemployment Benefits" *Economic Journal* **115:** 631-48.

Bivens, J. and L. Mishel (2013) "The Pay of Corporate Executives and Financial Professionals as Evidence of Rents in Top 1 Percent Incomes" *Journal of Economic Perspectives* **27(3):** 57–78.

Blanchard, O. and P. Diamond (1989) "The Beveridge Curve" *Brookings Papers on Economic Activity* **1989 (1):** 1–76.

Braguinsky, S., L. Branstetter and A. Regateiro (2011) "The Incredible Shrinking Portuguese Firm" NBER working paper #17265.

Burdett, K., and D. T. Mortensen (1998) "Wage Differentials, Employer Size, and Unemployment" *International Economic Review* **39(2):** 257-73.

Burdett, K. and T. Vishwanath (1988) "Balanced Matching and Labor Market Equilibrium" *Journal of Political Economy* **96(5):** 1048-65.

Card, D., F. Devicienti and A. Maida (2014) "Rent-sharing, Holdup, and Wages: Evidence from Matched Panel Data" *Review of Economic Studies* **81:** 84–111.

Cole, H. and R. Rogerson (1999) "Can the Mortensen-Pissarides Matching Model Match the Business-Cycle Facts" *International Economic Review* **40(4):** 933-59.

Coles, M. and A. Masters (2007) "Re-entitlement Effects with Duration Dependent Unemployment Insurance in a stochastic Matching Equilibrium" *Journal of Economic Dynamics and Control* **31:** 2879-98.

Fullerton, D. and G. Metcalf (2002) "Tax Incidence" *Handbook of Public Economics,* A. Auerbach and M. Feldstein Eds. **4:** 1787-872.

Helpman, E., O. Itskhoki and S. Redding (2010) "Inequality and Unemployment in a Global Economy" *Econometrica* **78.4:** 1239–83.

Hornstein, A., P. Krusell and G. Violante (2011) “Frictional Wage Dispersion in Search Models: A Quantitative Assessment” *American Economic Review* **101:** 2873-98.

Hosios, A. (1990) “On the Efficiency of Matching and Related Models of Search and Unemployment” *Review of Economic Studies* **57:** 279-98.

Lucas R. (1978) “On the Size Distribution of Business Firms” *The Bell Journal of Economics* **9(2):** 508-23.

Masters, A. (2011) “Commitment, advertising and efficiency of two-sided investment in competitive search equilibrium” *Journal of Economic Dynamics and Control* **35:** 1017-31.

Menzio, G. (2007) “A Theory of Partially Directed Search” *Journal of Political Economy* **115:** 748-69.

Petrongolo, B. and C. Pissarides (2001) “Looking into the Black Box: A Survey of the Matching Function” *Journal of Economic Literature* **39 (2)** 390–431.

Piketty, T., E. Saez and S. Stantcheva (2011) “Optimal Taxation of Top Labor Incomes: A Tale of Three Elasticities” NBER Working Paper No. 17616.

Pissarides, C. (2000) *Equilibrium Unemployment Theory.* Oxford: Basil Blackwell.

Saez, E., J. Slemrod and S. Giertz (2012) “The Elasticity of Taxable Income with Respect to Marginal Tax Rates: A Critical Review” *Journal of Economic Literature* **50(1):** 3-50.

Shimer, R. (2006) “On-the-job Search and Strategic Bargaining” *European Economic Review* **50:** 811–30.