Taxing Capital is Not a Bad Idea Indeed:
The Role of Human Capital and Labor-Market Frictions

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Dynamic factor tax incidence is an important policy issue because, in the real world:

- there is no easy access to a true lump-sum tax (2nd-best)
- capital and labor income taxes are broad based

The Chamley-Judd-Lucas proposition: the optimal flat factor tax scheme is to impose no tax on either physical or human capital, but to tax raw labor (see also Jones-Manuelli-Rossi 1993, 1997; Cassou-Lansing 2006)

Conesa-Kitao-Krueger (2009): a call for taxing capital may be due to

- borrowing constraints
- uninsurable idiosyncratic income risk
- life-cycle settings with the age-independent tax code

Question: whether taxing capital is not a bad idea after all in an infinite-lifetime deterministic model without borrowing constraint or uninsurable income risk.
Contribution

- Develop an endogenous growth model with:
  1. general human capital accumulation depending on market goods (physical capital)
  2. endogenous labor participation/vacancy creation
  3. nonnegligible search/entry frictions

- We show that the various labor-related tradeoffs can reverse the Chamley-Judd-Lucas recommendation:
  - a switch from labor to capital tax raises the wage discount, encourages vacancy creation, and induces workers to participate in the labor market more actively
  - through this “vacancy creation-labor participation” channel, equilibrium employment and economic growth may rise
  - so the optimal capital tax need not be zero when labor-market frictions are nonnegligible
  - by calibrating the U.S. economy with pre-existing 20% taxes on capital and labor income, the optimal tax mix is $(\tau_K^*, \tau_L^*) = (6.33\%, 62.13\%)$ in the benchmark case.
The Environment

- An infinite, discrete time model comprises of
  - a continuum of identical infinitely lived competitive firms (of measure one)
  - a continuum of identical infinitely lived households (of measure one)
  - a fiscal authority determining revenue-neutral optimal factor tax mix
- The goods market is Walrasian and the capital market is perfect, but the labor market exhibits search/matching/entry frictions
- Vacancy creation and labor participation/search are costly
- Vacancies and job seekers are brought together through a random matching technology
- Each vacancy can be filled by one searching worker
- Filled vacancies and employed workers are separated every period at an exogenous rate.
Firms

- Let $s_t$ and $(1 - s_t)$ respectively represent fractions of physical capital used for production and human capital accumulation and $x_t = \ell_t h_t$ be effective labor per unit of employment.
- A representative firm rents capital $s_t k_t$ at rate $r_t$ and employs labor $n_t$ with effort $\ell_t$ at a recruitment rate $\eta_t$ at wage $w_t$ to produce final good $y_t$.
- Vacancy creation/maintenance cost: $\Phi(v_t) = \phi \bar{y}_t v_t$
- Optimization:

\[
\Gamma(n_t) = \max_{v_t, k_t} \frac{A(s_t k_t)^{\alpha}(n_t x_t)^{1-\alpha} - w_t n_t x_t - r_t s_t k_t - \phi \bar{y}_t v_t}{x_t} + \frac{1}{1 + r_t} \Gamma(n_{t+1})
\]

s.t. $n_{t+1} = (1 - \psi)n_t + \eta_t v_t$. 
Households I

- Large household: all resources pooled
- Income sources: labor wage, capital rental, government transfer
- Labor allocation:

\[
1 \xrightarrow{n \text{ (employed)}} \ell n \text{ (work)} \xrightarrow{(1-\ell)n \text{ (learning)}} 1-n \text{ (nonemployed)}
\]
Households II

- Inelastic leisure
- Human capital accumulation
- Job finding rate: $\mu_t$
- Optimization:

$$\Omega(k_t, h_t, n_t) = \max_{c_t, \ell_t} \left[ U(c_t) + \frac{1}{1+\rho} \Omega(k_{t+1}, h_{t+1}, n_{t+1}) \right]$$

s.t.  

$$k_{t+1} = (1-\tau_L)\omega h_t \left[ n_t \ell_t + (1-n_t)\bar{b} \right] + [1-\delta_k + (1-\tau_K)r_s t]k_t - c_t + T_t$$

$$h_{t+1} = h_t + Dn_t (1-\ell_t)h_t + \tilde{D}\left[(1-s_t)k_t\right] \gamma \left[n_t (1-\ell_t)h_t\right]^{1-\gamma}$$

$$n_{t+1} = (1-\psi)n_t + \mu_t (1-n_t).$$
Matching, Bargaining and Government Behavior

- Matching technology:
  \[ M_t = B(1 - n_t)^\beta (v_t)^{1-\beta} \]

- Cooperative Nash bargain:
  \[
  \max_{w_t} (\Omega_{n_t})^{\zeta} (\Gamma_{n_t})^{1-\zeta} \Rightarrow \frac{\beta}{w_t} \left( \frac{w_t}{\Omega_{n_t}} \frac{d\Omega_{n_t}}{dw_t} \right) = -\frac{1 - \beta}{\Gamma_{n_t}} \frac{d\Gamma_{n_t}}{dw_t}
  \]

- Government behavior: Solve the dynamic tax incidence problem by maximizing the balanced-growth augmented household value, \( \Lambda((c + \pi)/h, g) \), subject to all the policy functions obtained from household, firm and bargaining problems and the government budget constraint:
  \[ T_t + w_t h_t (1 - n_t) \bar{b} = \tau_L w_t h_t \left[ n_t \ell_t + (1 - n_t) \bar{b} \right] + \tau_K r_t s_t k_t. \]
Key Trade-offs

- Effective capital-labor ratio: \( q^H = \frac{(1 - s)k}{n(1 - \ell)h} \) and \( q^F = \frac{sk}{n\ell h} \)

- Intratemporal and intertemporal trade-offs:

(capital demand) \( MPK = \alpha A \left(q^F\right)^{\alpha - 1} = r \)

(vacancy creation) \( \frac{1}{1+r} \Gamma_n(n') = \frac{\phi A(q^F)^\alpha n}{\eta} \)

(labor-learning) \( \frac{(1-\tau_L)w}{(1-\tau_L)r} = \frac{D + \tilde{D}(1-\gamma)(q^H)\gamma}{D\gamma(q^H)^{\gamma-1}} \)

(human capital, HH) \( \frac{(1-\tau_L)w}{(1-\tau_K)r} = \frac{D + \tilde{D}(1-\gamma)(q^H)\gamma}{D\gamma(q^H)^{\gamma-1}} \)

(labor participation) \( \frac{1}{1+\rho} \Omega_n(n') = \frac{(1-\tau_L)(1-\bar{b})w}{(\rho + \psi + \mu)c/h} \)

(consumption-saving) \( MRIS = (1 + \rho) \frac{U_c}{U_c'} \).
Steady-state matching and Beveridge curve:

\[ \psi n = \mu(1 - n) = \eta v = B(1 - n)^\beta (v)^{1-\beta} \]

Equilibrium matching rates/vacancies, all depending on \( n \):

- job finding rate: \( \mu(n) = \frac{\psi n}{1-n} \)
- employee recruitment rate: \( \eta(n) = B^{\frac{1}{1-\beta}} \mu(n)^{\frac{-\beta}{1-\beta}} \) (Beveridge curve as in Laing-Palivos-Wang 1995)
- equilibrium vacancies: \( v(n) = B^{\frac{-1}{1-\beta}} \mu(n)^{\frac{\beta}{1-\beta}} \psi n \) (vacancy-employment complementarity)

Labor-market tightness: \( \theta(n) = \frac{v}{1-n} = \left[ \frac{\mu(n)}{B} \right]^{\frac{1}{1-\beta}} \).
Definition: DSE and BGP

A dynamic search equilibrium is a tuple of consumption, capital, output, labor allocation, vacancy, and matching variables together with a pair of factor prices such that:

1. all firms and households optimize
2. human capital and employment evolution hold
3. matching and bargaining conditions are met
4. government budget is balanced
5. the goods market clears

Definitions

A balanced growth path (BGP) is a dynamic search equilibrium along which consumption, physical and human capital, and output all grow at positive constant rates.
Balanced Growth Path

- Utility function to accept a BGP: \( U(c_t) = \ln c_t \)
- Define: \( S_w \equiv (1-\tau_L) \left[ 1 + (1-n) \frac{\bar{b}}{n\ell} \right] \); \( S_r \equiv (1 - \tau_K)r - \frac{\delta_k + g}{s} \)
- Key BGP relationships:
  
  (Keynes-Ramsey) \[ g = \frac{(1-\tau_K)rs - (\rho + \delta_k)}{1+\rho} \]
  (human capital, HA) \[ g = \frac{[D+\tilde{D}(1-\gamma)(q^H)\gamma][n+(1-n)\bar{b}] - \rho}{1+\rho} \]
  (labor-learning, LL) \[ \ell = 1 - \frac{(1-\gamma)g}{n} \left[ \frac{(1+\rho)g + \rho}{n+(1-n)\bar{b}} - \gamma D \right]^{-1} \]
  (consumption) \[ \frac{c}{\bar{h}} = \left( S_w \bar{w} + S_r q^F \right) n\ell + \frac{T}{\bar{h}} \]
  (firm efficiency, FE) \[ \frac{\eta}{\psi + r} \left[ (1 - \alpha) q^F - \frac{\alpha w}{r} \right] = \phi n q^F. \]
Equilibrium Bargaining

- Household-firm pair in the bargaining game takes \( \{\mu, \eta, n, r\} \) as given.
- Wage discount:
  \[
  \Delta (n,g) \equiv \frac{MPL - w}{MPL} = 1 - \frac{w}{(1 - \alpha)A (q^F)^\alpha}
  \]
- Responsiveness: 
  \[
  - \frac{w}{\Gamma_n} \frac{d\Gamma_n}{dw} = \frac{1-\Delta}{\Delta} \quad \text{and} \quad \frac{w}{\Omega_n} \frac{d\Omega_n}{dw} = \frac{S_rq^F + \frac{T}{h_{nl}}}{S_w w + S_rq^F + \frac{T}{h_{nl}}}.
  \]
Bargaining Outcomes

- Nash bargain (NB):

\[ MB_w = \frac{\beta \left[ S_r q^F + T / (n \ell h) \right]}{S_w w + S_r q^F + T / (n \ell h)} = \frac{(1 - \beta)w}{(1 - \alpha)A (q^F)\alpha - w} = MC_w \]

- higher \( \tau_K \)
  - reduces \( S_r \) \( \Rightarrow \) household’s \( MB_w \downarrow \Rightarrow w \downarrow \)
  - reduces \( \ell \) \( \Rightarrow \) raises \( T / (n \ell h) \) \( \Rightarrow \) household’s \( MB_w \uparrow \Rightarrow w \uparrow \)

- higher \( \tau_L \)
  - reduces \( S_w \) \( \Rightarrow \) household’s \( MB_w \uparrow \Rightarrow w \uparrow \)
  - lowers \( \ell \) \( \Rightarrow \) raises \( T / (n \ell h) \) \( \Rightarrow \) household’s \( MB_w \uparrow \Rightarrow w \uparrow \)

- so a higher \( \tau_L \) raises \( w \) but lowers \( (1 - \tau_L)w \), \( \Delta \) and vacancy creation \( v \); a higher \( \tau_K \) causes ambiguous effects on \( w, (1 - \tau_L)w, \Delta \) and \( v \).
Bargained wage and wage discount

- Responses to a higher $\tau_K$ or $\tau_L$ in the benchmark:
Equilibrium wage discount, employment and growth

- An increase in $\tau_L$ lowers $\Delta$, $\nu$ and $(n, g)$ by more than an increase in $\tau_K$
Benchmark Parametrization

- Calibrate to fit post-WWII U.S. quarterly data
- \( g = 0.45\% \) (annual rate = 1.8\%), \( \delta_k = 0.01 \) (annual rate = 4\%), \( \rho = 0.01 \) (annual rate = 4\%), \( \alpha = 0.36 \)
- \( k/h = 1 \) (Kendrick 1976), \( \frac{v}{1-n} = 1, \bar{b} = 0.4 \) (Shimer 2005)
- Monthly separation/job finding rates = 0.034, 0.45 \( \Rightarrow \)
  \( \psi = 1 - (1-0.034)^3 = 0.0986, \)
  \( \mu = 1-(1-0.45)^3 = 0.834 = \eta = B \) (quarterly);
  \( n = \frac{\mu}{\mu+\psi} = 0.894, \nu = \frac{\psi n}{\eta} = 0.106 \)
- Set \( D = 0.018, \ell = 0.725 \Rightarrow q^F = 1.54, q^H = 0.002 \Rightarrow \)
  \( r = 0.0338, A = 0.124 \)
- \( k/y = 10.64 \) (annual ratio = 2.66\%) \( \Rightarrow \bar{D} = 0.0019 \)
- \( HH \Rightarrow w = 0.0122 \Rightarrow \beta = 0.130, \Delta = 86.88\% \Rightarrow \) from \( FE, \)
  \( \phi = 3.915 \)
- Pre-existing taxes: \( (\tau_K, \tau_L) = (20\%, 20\%) \).
Tax Incidence Results I

- **Effective Consumption** vs. Capital Tax Rate
- **Economic Growth Rate** vs. Capital Tax Rate
- **Lifetime Utility** vs. Capital Tax Rate
- **Firm's Value** vs. Capital Tax Rate
Welfare measure: \[ \Lambda \left( \frac{c + \pi}{h}, g \right) = \frac{1+\rho}{\rho} \left[ \ln \left( \frac{c + \pi}{h} \right) + \frac{1}{\rho} \ln \left( 1 + g \right) \right], \]

where \[ \frac{\pi}{h} = n \ell \left[ (1 - \alpha) A \left( q^F \right)^\alpha - \omega \right] \]

Optimal factor tax mix:

\[ (\tau^*_K, \tau^*_L) = (6.33\%, 62.13\%) \]

such a tax reform \( \rightarrow \) 1.38% increase in economic growth, 0.895% increase in welfare (in consumption equivalence).
Main Findings

- The numerically dominant channel: the *vacancy creation-labor participation* channel
  - under an efficiency wage bargain, a shift to a positive capital tax accompanied by a lower labor tax
    - raises the wage discount
    - encourages vacancy creation
    - induces workers to more actively participate in the labor market to seek employment
  - such a shift increases equilibrium employment and economic growth
  - so the optimal capital tax need not be zero when labor-market frictions are nonnegligible.
Alternative Setups

- 3 alternative models:

<table>
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<th>%</th>
<th>$\tau_K^*$</th>
<th>$\tau_L^*$</th>
<th>$\Delta g$</th>
<th>$\Delta \Lambda$ in CE</th>
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<td>Benchmark</td>
<td>6.33</td>
<td>62.13</td>
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<td>0.895</td>
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</table>

- elastic leisure $\implies$ more in favor of taxing labor due to the valuation of nonmarket activity, but reform still featuring strictly positive capital taxation
- linear human capital formation ($\tilde{D} = 0$) $\implies$ the absence of market goods as HCA inputs $\implies$ overall distortion of $\tau_L \downarrow$ $\implies$ optimal to fully eliminate capital taxation by imposing tax only on labor income
- in a Walrasian setting without labor-market frictions, $(\tau_K^*, \tau_L^*) = (0\%, 27.51\%)$, reconfirming Lucas $(0\%, 46\%)$
- Labor-market frictions and general HCA are key to our main findings.
Future Work:

1. to incorporate a pecuniary vacancy creation cost that requires capital financing: the presence of credit market frictions as a result of private information is anticipated to increase the capital tax distortion and more in favor of taxing labor.

2. to allow the separation rate to depend on on-the-job learning effort (as in Mortensen 1988): since labor income taxation discourages on-the-job learning, it is anticipated that such an extension may cause labor taxation to be more distortionary and favor taxing more heavily on capital income.