Online Appendix for Product Market Regulation and Market Work: A Benchmark Analysis

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A. General Balanced Growth Preferences

Section 2 derived the main results of the paper using a special form of preferences consistent with balanced growth. This section confirms that these results also hold for more general preferences consistent with balanced growth. The representative household now has preferences given by:

$$\frac{[cg(1-h)]^{1-\sigma}-1}{1-\sigma},$$

where g is a concave function.

A.1. Equilibrium

When there are no taxes or regulations, the household maximize utility subject to budget constraint $c = w^*h$. Simple calculation gives the first order condition:

$$\frac{g'(1-h)h}{g(1-h)} = 1 \tag{A.1}$$

A.2. Labor Taxes and Market Work

When the government imposes a proportional tax τ on labor income, the household's budget constraint changes to $c = (1-\tau)w^*h + T^*$ where $T^* = \tau w^* h$ if the tax revenue is rebated back in a lump-sum fashion and $T^* = 0$ if the tax revenue is discarded.

If the tax revenue is discarded, the first order condition is given by:

$$\frac{g'(1-h)h}{g(1-h)} = 1 \tag{A.2}$$

With lump-sum transfers, the first order condition is given by:

$$\frac{g'(1-h)h}{g(1-h)} = (1-\tau) = \frac{1}{(1+\frac{\tau}{1-\tau})} \tag{A.3}$$

Note that the above two equations have the same form as the equations determining the labor supply in section 2.2.

A.3. Product Market Regulation and Market Work

This section explores the effect of the regulatory policies examined in section 2.3 with more general preferences. To begin with, since the household's budget constraint is $c = w^*h$ in the the three cases corresponding to entry barriers representing a real resource cost, entry barriers representing a nominal cost with the proceeds from the entry fee thrown away, or where the size of the firms is restricted below their equilibrium value, the equation that determines labor supply in these cases is again given by:

$$\frac{g'(1-h)h}{g(1-h)} = 1 \tag{A.4}$$

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When the proceeds from the entry fee are rebated back, the budget constraint changes to $c = w^*h + T$ where T is the size of the transfers. Solving the household's maximization problem gives:

$$\frac{g'(1-h)h}{g(1-h)} = \frac{1}{1 + \frac{T}{w^*h}} \tag{A.5}$$

As in section 2.3.3, if the government grants $\bar{N}$ permits, the household's budget constraint will be $c = w^*h + \pi$ where π is the profit earned by the intermediate producers. The first order condition of the household's maximization problem is then given by:

$$\frac{g'(1-h)h}{g(1-h)} = \frac{1}{1 + \frac{\pi}{w^*h}} \tag{A.6}$$

Comparing the above equations with the equations in section 2, it is easy ti see that the predictions in section 2 continue to hold under general preferences that consists with balanced growth.

B. Dynamic Analysis

In this appendix we build and calibrate a monopolistic competition version of the dynamic industry equilibrium model used by Hopenhayn and Rogerson (1993) to study the effects of firing taxes, and use it to assess the steady state effects of entry barriers. This analysis is of potential interest for three reasons. First, in a dynamic setting, entry barriers will influence both the entry and exit decision, and therefore influence the distribution of firm level productivities via a selection effect. A dynamic model allows us to evaluate this effect. Second, whereas in a static model the free entry condition implies that profits are zero in equilibrium, in a dynamic model the free entry condition only implies that the expected present value of profits are equal to zero. If interest rates are positive, this does not imply that the steady state profit flow is equal to zero. Changes in steady state profits induce income effects on labor supply and hence our dynamic model allows us to evaluate this additional effect. Finally, this analysis allows us to compare the effects of entry barriers and firing taxes. Hopenhayn and Rogerson (1993) found that firing taxes had somewhat small but negative effects on hours of work. Since the direct effects of entry barriers and firing taxes is similar, in that both distort the allocation of labor across establishments, one might infer that the labor market effects would also be similar. We argue that the Hopenhayn and Rogerson (1993) result requires an important qualification. Consistent with our previous analysis, we show that the effects of firing taxes on hours of work depend critically on whether the firing taxes represent a real resource cost as opposed to being a source of revenue that leads to a lump-sum transfer. While entry barrier and firing taxes that represent real resource costs do have important effects on allocations and welfare, our quantitative analysis finds that the effect of these policies on hours of work is effectively zero.

B.1. Model and Calibration

There is a single household, with preferences over consumption (c_t) and leisure $(1 - h_t)$ given by:

$$\sum_{t=0}^{\infty} \beta^t [\alpha \log(c_t) + (1 - \alpha) \log(1 - h_t)] \tag{B.1}$$

where $0 < \beta < 1$ is a discount factor. Note that we have imposed preferences that are consistent with balanced growth, implying that income and substitution effects are offsetting. The household in endowed with one unit of time each period.

As in the static analysis, we assume that there are two production sectors, one that combines intermediate goods into the final output good, and another that uses labor to produce intermediate goods. We assume that the final good sector is competitive with a constant returns to scale technology, and so for simplicity assume that it consists of a single firm, with a production function given by:

$$Y_t = [\int_0^{N_t} y_t(i)^\rho di]^{1/\rho} \tag{B.2}$$

where N_t is the mass of intermediate goods firms at time t.

Firms in the intermediate goods sector are subjected to persistent idiosyncratic productivity shocks and face two fixed costs. As in the static model we assume that there is a fixed labor cost associated with entry, which we denote by h_e. In order to generate endogenous exit, we also assume that there is a fixed per period operating cost, which is also expressed in units of labor and is denoted by h_f. Consider a firm that produced in period $t - 1$ and had productivity parameter A_{t-1}. At the beginning of period t, this firm must decide whether to remain in operation or exit. If it chooses to remain in operation it must pay the fixed cost h_f. If it pays this cost, it will learn its new productivity, which is described by a density function $f(A_t, A_{t-1})$. We assume that a higher value of A_{t-1} leads to a distribution of A_t that first order stochastically dominates the previous distribution. The process for the idiosyncratic shocks is the same for all intermediate firms, but the realization of the shocks is iid across firms. If the firm paid the cost h_f and received a new draw A_t it then faces a linear production technology given by:

$$y_t = A_t h_t \tag{B.3}$$

If a firm chooses to not pay the fixed cost h_f then it exits and ceases to exist.

We also need to specify how the initial productivity for new entrants is set. We assume that entry occurs in the beginning of the period, prior to any production decisions. Hence, if a firm pays the entry cost h_e at the beginning of period t it will be able to produce in period t and its idiosyncratic productivity will be a random draw from a distribution with density $g(A)$. All of the fixed costs for entrants are captured by h_e, and so all entrants will produce for at least one period no matter how low their productivity is. All potential entrants draw from the same distribution, but the draws

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are iid across entrants. We assume that each firm produces a different intermediate good, so that the mass of intermediate goods is the same as the mass of firms. All of the firms (including potential firms) are owned by the household.

We focus on the steady state equilibrium for this model, assuming that intermediate goods producers behave as monopolistic competitors in the product market, and that all other markets are competitive. There is an unlimited number of potential entrants into the intermediate goods sector, so that in equilibrium the net profit from entering must equal zero. Some notation will help to outline the specifics in more detail. Normalize the wage rate to one and let p_c be the equilibrium price of the final good. Because our intermediate producers are no longer symmetric there will no longer be a single price for intermediate goods. We let $p(A)$ denote the price charged by an intermediate producer who has current productivity A. Given a mass of intermediate goods producers equal to N, the problem of the final good producer reduces to a sequence of static problems, and as is standard, the demand for each input is a constant elasticity demand function with own price elasticity equal to $1/(1-\rho)$ and scale parameter B, i.e., demand is given by $Bp^{1/(\rho-1)}$ for some constant B. In equilibrium, B will be a function of the mass of firms, N, the outputs of each of the firms (y_j), and the price of the final good p_c, given by:

$$B = p_c^{1/(1-\rho)}[\int_0^N y_j^\rho dj]^{1/\rho} \tag{B.4}$$

Let $\mu(A)$ denote the measure of firms in the current period after the fixed operating costs have been paid (i.e., after the exit decision has been taken) the new realizations of productivity have been realized, and entry has taken place. The mass of intermediate goods producers is given by $N = \int \mu(A)dA$. Recalling that we have normalized the wage to be one, the value function for a firm at this point in time is given by:

$$V(A) = \max_{p,h}\{pAh - h\} + \beta\max\{0, -h_f + \int V(A')f(A', A)dA'\} \tag{B.5}$$

subject to taking the demand function for its product as given. Note that the only dynamic decision involves whether to exit at the beginning of next period. Independently of whether the firm plans to exit at the beginning of the next period, the optimal decision for price and labor input are determined by maximizing current period profits, since the operating cost paid earlier in the period represents a sunk cost at this point. It follows that the optimal pricing decision will be a markup over marginal cost, so that the equilibrium price for an intermediate goods firm with current productivity A will be $p(A) = \frac{1}{\rho}\frac{w}{A}$. Let $h(A)$ be the optimal decision rule for labor demand, and let $X(A)$ denote the optimal decision rule for the exit decision at the beginning of the next period with the convention that $X = 1$ denotes exit. Given our assumption that higher A today leads to a distribution of A tomorrow that is first order stochastically higher, it is straightforward to show that the function V is weakly increasing in A and hence that the optimal exit rule will be described by a reservation rule: exit if $A < \bar{A}$. For

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future reference we note that it is also straightforward to show that the value function V is increasing in the scale parameter B.

Next consider the problem of a potential entrant. The expected value from entering the market is given by:

$$-h_e + \int V(A)g(A)dA \qquad \text{(B.6)}$$

If there is entry in the steady state equilibrium then this value must equal zero.[1] Since the value function V is increasing in the scale of demand for intermediate goods, it follows that the zero profit condition will uniquely pin down the value of B. Given the value of B, one can solve for the optimal decision rules $h(A)$ and $X(A)$.

There are two remaining equilibrium values to be determined: the level of entry, E, and the price of the final good, p_c. In general these values need to be solved for jointly, but our assumption that utility from consumption takes the form of $\log c$ implies that the values of E and p_c can be determined sequentially. In particular, the steady state equilibrium level of entry is determined by the labor market clearing condition. To see this, note first that the household labor supply decision in steady state reduces to a static problem of maximizing current period utility taking the price p_c and current profit flow, which we denote by π, as given. The choice of $\log c$ for the utility function implies that labor supply is independent of p_c so we can write the optimal labor supply choice as $H^S(\pi)$. Note that although free entry implies that the net discounted profit from entry is equal to zero in equilibrium, it does not follow that the current flow of profit is equal to zero, since the interest rate is positive. Given our preference specification, leisure is a normal good and this function is decreasing in π. The labor market clearing condition in steady state equilibrium can be written as:

$$\int (h(A) + h_f)\mu(A)dA + E(h_e - h_f) = H^s(\pi) \qquad \text{(B.7)}$$

Note that we multiply E by $(h_e - h_f)$ since we assumed that the fixed operating cost is included in the entry cost. Given decision rules $h(A)$ and $X(A)$, one can easily show that the resulting invariant distribution $\mu(A)$ is scaled proportionately by E, as is the aggregate profit flow π. It follows that this equation uniquely determines steady state entry. Having determined entry, and given that we know the steady state value of B, it follows that we can determine the steady state value of p_c from equation (B.4).

There are a few properties of the steady state equilibrium that one can infer from the above constructive argument that are worth noting in terms of the future analysis. First, changes in taxes will affect the labor supply function H^S. But they will not affect the steady state value of B that emerges from the free entry condition, and hence will not affect the decision rules $h(A)$ and $X(A)$. It follows that taxes will affect the scale of the steady state distribution μ but not its shape. As a result many statistics will not change,

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[1] As in the analysis of Hopenhayn and Rogerson (1993), it is possible that there does not exist a steady state equilibrium with entry. Given that we calibrate the model to be consistent with entry in the steady state equilibrium, we focus only on this case.

such as average firm size and the exit rate. While the productivity of intermediate goods producers will not be affected, there will be an aggregate productivity effect associated with the change in N. Similarly, in the case of a change in h_e, the effect on firm decision rules will be independent of whether the increase represents a real resource cost or is used to fund a transfer payment to households. It follows that variables such as the entry rate and average firm size will not be affected by this difference.

Having laid out the model and qualitatively described some features of the equilibrium, we will next turn to a quantitative analysis of the effect of product market regulations. To do this it is necessary to choose functional forms for the stochastic elements of the model and to assign parameter values. To facilitate comparison with earlier work, we follow the choices of Hopenhayn and Rogerson (1993) where possible. Although the values of many of the parameters are jointly determined, it is useful to describe the calibration procedure as linking specific parameter values and targets. As in Hopenhayn and Rogerson, we set the time period equal to five years. The preference parameter α is chosen so that total hours of work in the steady state is equal to .3, and the resulting value is .3042. The discount factor is the five year equivalent of .96 per year, which equals .80. We assume that the constant term B in the demand for intermediate goods by the final good producer is equal to one in equilibrium. This is equivalent to normalizing the price of the final good, which is tantamount to a choice of units. We assume that the idiosyncratic shock process follows an $AR(1)$ process on $log(A)$, with persistence ρ_A and log normal innovations, and that the distribution for entrants is uniform. As in Hopenhayn and Rogerson, based on data from the LED we set the persistence parameter equal to .93 and the standard deviation of the innovations to be .2621. With B normalized to one, the free entry condition determines the calibrated value of h_e. The mean of the innovation influences the mean productivity, and h_f influences the reservation productivity value. These two values are chosen so as to match a five year exit rate of .37 and an average firm size of 61.[2] For our benchmark specification we set $\rho = 5/6$, implying that markups will be 20% in equilibrium. This value is at the upper end of what many studies assume, but in terms of the effects on hours of work we found that the results are basically the same for smaller values so will only report results for this case. The one dimension that is affected by the value of ρ is the size of the aggregate productivity effects, since the policies that we consider will typically influence the mass of firms operating in the steady state equilibrium, and the magnitude of how this affects aggregate productivity is very much dependent on ρ.

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[2]Our model only says how many hours a firm hires. We convert this to workers by assuming that a worker works 40 hours a week for 52 weeks a year for five years, and express this relative to the time endowment which assumes 100 hours per week. Our model is homogeneous of degree one in population, so the number of firms is linear in the size of the population. While normalizing the population size to be one and having an average firm size equal to 61 may sound peculiar, it simply implies that we have a small mass of firms operating in equilibrium. But assuming population of 300 million would have zero effect on all of our reported results.

B.2. Results

We are now ready to evaluate some of the policies examined earlier in the paper in the static version of the model. But before we do so it is important to note one feature of the steady state equilibrium. As noted earlier, although free entry implies that the expected present discounted value of profits for an entrant is equal to zero, it does not follow that the one period aggregate profits are equal to zero in steady state. Nonetheless, the aggregate one period profit flow is very small, amounting to only 2% of labor income.

We begin by considering the effects of an increase in labor taxes when they are used to fund a lump-sum transfer. As is standard in this literature, we focus on the comparison of what happens when taxes are increased from .30 to .50, since this reflects the typical values for the US versus countries in continental Europe. Table B1 presents the results, where all values are values for the high tax economy relative to the lower tax economy.

Table B1					
Outcomes for $\tau = .5$ Relative to $\tau = .3$					
H	E/N	Y/H	π	N	H/N
.76	1.00	.95	.77	.76	1.00

The effect of a twenty percent increase in the tax rate used to fund a lump sum transfer reduces steady state hours of work by about 1/4. We note that this is effectively the same prediction that one would obtain from the static analysis carried out earlier in the paper. Relative to the static model, and as noted previously, this model has one additional margin that could influence the labor supply response, and that is the effect on profits. Although the tax and transfer policy has a substantial impact on profits in percentage terms, because profits are small relative to labor income, the effect of this change on labor supply is very small. Consistent with earlier comments on the construction of the steady state equilibrium, taxes have no effect on the entry rate or on average firm size. The large decrease in N produces substantial effects on productivity, though we note that if markups were 10% instead of 20%, this effect would be less than one-half as large.

We now turn to an analysis of the effect of entry barriers.[3] We consider the case of an increase in entry costs h_e due to license fees, which we denote by κ. As in the earlier analysis, we assume that κ is measured in units of labor so that the effective entry cost becomes $h_e + \kappa$. We then consider two separate cases, depending upon what is done with the revenue that is raised by the fees.[4] Table B2 reports the results for the case in which revenues are discarded. Once again, all values are relative to the initial steady state.

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[3] We have also examined the effects of changes in the per period fixed cost. The basic results are the same as for the entry barrier, and so in the interest of space we do not report them.

[4] As in the static analysis, the case in which the revenues are discarded is equivalent to the case in which the higher entry fee represents a real resource cost, so we do not report separate results for the case of an increase in real resource costs.

Table B2

			Effects of Entry Fee, Proceeds Discarded			
κ/h_e	H	E/N	Y/H	π	N	H/N
.20	.999	.96	.99	1.05	.88	1.14
.50	.998	.93	.98	1.10	.73	1.35
1.00	.997	.86	.96	1.16	.61	1.64
3.00	.996	.67	.88	1.30	.39	2.50

The simple message from this table is that such a policy has virtually no effect on hours of work. As expected, the policy reduces the entry rate, leading to fewer firms that are on average larger. Whereas the increase in labor taxes leads to a significant decrease in the steady state profit flow, an entry fee leads to a significant increase in this flow. But once again, although this policy produces a sizeable increase in profits in percentage terms, the change is small relative to labor income and as a result the effect on hours of work is virtually nonexistent.

Table B3 considers the case where the entry cost is rebated to consumers.

Table B3

			Effects of Entry Barrier, Proceeds Rebated				
	H	E/N	Y/H	π	N	H/N	T/wH
$\kappa/h_e = .20$	.98	.96	.99	1.03	.86	1.14	.022
$\kappa/h_e = .50$	.97	.93	.98	1.07	.71	1.35	.047
$\kappa/h_e = 1.00$	.95	.86	.95	1.11	.57	1.64	.073
$\kappa/h_e = 3.00$	.92	.67	.87	1.20	.37	2.50	.117

In this case we now see that there is a noticeable effect on hours of work if the change in entry costs is sufficiently large. But the key point here is the final column of the table, which shows the value of the transfer generated by the entry fees, relative to labor income. What it shows is that an entry fee that is sufficiently large so as to fund a transfer payment equal to more than 10% of labor income would indeed reduce steady state hours of work by 8%. In fact, this is effectively the same response that one would find from a labor tax that lead to a transfer payment equal to this fraction of (after-tax) labor income. That is, the differential effect associated with the different effects on the steady state profit flow is virtually negligible in terms of its effect on hours of work.

Next we consider the case where the product market regulation takes the form of restricting entry, but occurs directly instead of via changes in the entry cost. This case is of interest quantitatively because one would expect that this is the case that will lead to the largest increase in profits, and thereby the largest effect on hours of work. Table B4 displays the results. We use E^* to denote the level of entry in the benchmark steady state equilibrium.

Table B4

Direct Restriction on Entry						
	H	E/N	Y/H	π	N	H/N
$E/E^* = .80$	.98	.97	.99	2.52	.81	1.21
$E/E^* = .60$	.96	.90	.96	4.03	.64	1.51
$E/E^* = .40$	.94	.80	.92	5.56	.47	2.02

The basic pattern of results here is similar to that in the previous table, except that now the key channel is profits as opposed to the transfer funded by the entry fee. Specifically, one can see from the fourth column that this policy has a dramatic effect on profits. Even though profits in the initial steady state are very small relative to labor income, the fact that profits increase more than fivefold when entry is reduced by 60% relative to the initial steady state implies that the effect becomes substantial. By way of comparison we note that the increase in profits relative to labor income for the case in which $E/E^* = .40$ is roughly 10%, and that the effect on hours worked is effectively identical to that which results from the case in which the entry fee leads to a transfer payment equal to 10% of labor income. That is, in terms of assessing the effects on hours of work, it is sufficient to know the size of the increase in non-labor income relative to labor income.

For completeness we also consider the effect of a change in ρ. Blanchard and Giavazzi (2003) argued that some product market regulations could be understood in a reduced form sense as effectively changing ρ to the extent that product market regulation might impact on markups, and in equilibrium ρ is the markup. In their analysis they abstracted from productivity effects associated with variety, whereas we have not, so we add an additional qualification up front that the productivity effects associated with a change in ρ should probably not be taken seriously if one is interpreting the change in ρ as being due to a change in product market regulation whose direct effect is a change on markups. Table B5 shows the results.

Table B5						
Effect of Changes in ρ						
	H	E/N	Y/H	π	N	H/N
$\rho = 1/1.15$	1.001	1.19	2.24	.89	.64	1.57
$\rho = 1/1.25$	.997	.86	.46	1.21	1.40	.71
$\rho = 1/1.3$	.993	.67	.22	1.46	2.03	.49

The main result here is that this change has virtually no impact on steady state hours of work.

B.3. Comparison with Firing Taxes

While the focus of our analysis has been on the effect of product market regulation on hours of market work, it is of interest to compare the results that we obtain here with those obtained by Hopenhayn and Rogerson (1993) in their analysis of firing taxes. In

particular, they report that a firing tax equal to one year's wage leads to a reduction in hours of work of roughly 2.5%. At first glance one might conclude that firing taxes have larger effects on hours of work than do entry barriers. However, a closer analysis reveals that this conclusion is not warranted. In particular, one of the key messages of the analysis that we have undertaken above is that the effects of entry barriers on hours of market work depends critically on what is done with the revenue that is generated from the regulation, or more specifically, on the size of the effect of the regulation on income transfers relative to labor income. Hopenhayn and Rogerson assumed that the revenue from the firing taxes was used to fund a lump-sum transfer to all households. In light of the preceding analysis, we think it is interesting to ask to what extent the Hopenhayn and Rogerson results are affected by changing the assumption regarding the nature of the firing taxes. We note that both interpretations of the firing tax are reasonable, in the sense that one interpretation of the tax is that it reflects additional resources that a firm must expend in order to reduce the size of its payroll, either by hiring lawyers, meeting with government officials, preparing reports to justify the reduction in workforce etc... The other interpretation is that it reflects a lump-sum payment to workers. In this case it is critical that it reflect a lump-sum payment and not deferred compensation. We carry out an analysis of firing taxes in the context of our calibrated model, which differs slightly from Hopenhayn and Rogerson because of the assumption of differentiated intermediate goods and monopolistic competition in the intermediate good sector. Table B6 reports the results.

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Table B6

Effect of Firing Tax of 1 Year's Wage

	H	E/N	Y/H	π	N	H/N
Rebated	.96	.90	.98	.26	.86	.90
Not-Rebated	1.01	.90	.99	.28	.91	.90

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If one compares the results in the first row with those in Hopenhayn and Rogerson, one sees that the presence of monopolistic competition and the intermediate goods sector does alter the precise quantitative effects, though not the general nature of their results.[5] In particular, we find that productivity decreases by 2% and hours worked decrease by 4%, in contrast to values of 2.1% and 2.5% in Hopenhayn and Rogerson. But the key point is that when we look at the case where the revenues are not rebated, the results for productivity are similar (reducing by 1% instead of 2%), but the change in hours is now of a different sign: an increase of 1% versus a decrease of 4%. The reason for the increase in hours is that firing taxes lead to a significantly lower steady state profit flow. However, as was the case in the analysis of entry barriers, because

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[5]In Hopenhayn and Rogerson, the key curvature affecting firm level demand for labor comes from the assumption of decreasing returns to scale in production, whereas in the analysis here, the key curvature comes from the substitutability among intermediates. The calibrations imply different degrees of curvature and hence the effects of firing taxes differ somewhat.

profits are small relative to labor income, even a large percentage change in profits leads to a relatively small effect on hours of work.

B.4. Summary

The main result that we want to emphasize from the above simulations is that the results from our static analysis continue to hold in a dynamic model with more realistic processes for firm level dynamics, particularly for the processes of entry and exit. While the dynamic models do feature some additional effects relative to those in the static model, these effects turn out to be very small in our calibrated model. We also show that the results of Hopenhayn and Rogerson (1993) need to be interpreted with caution, since the same basic point applies equally well to the analysis of labor market regulations such as firing taxes. That is, the key mechanism that leads to changes in hours worked in their model is changes in non-labor income associated with the revenues from the firing taxes.