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TAXATION IN A SEARCH MODEL OF THE HOUSING MARKET

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Abstract

We analyze the effects of taxes on housing market transactions and, in doing so, distinguish between taxes on the seller (e.g. capital gains taxes) and taxes on the buyer. The theoretical framework is based on a search model developed by Wheaton (1990), which we extend by allowing for taxes. We demonstrate that, unless restrictions are imposed on the parameter values, Wheaton's original model yields theoretically unreasonable results. Having imposed the relevant restrictions, we show that both seller's and buyer's taxes create lock-in effects through reduced search effort, matching rates and sales rates. The magnitude of the lock-in effects crucially hinge on the vacancy rate. Taxes tend to further increase the difference between the privately optimal level of search effort and the socially optimal level and we show that a social optimum may be achieved by subsidizing housing transactions. The higher the vacancy rate, the larger is the required subsidy rate. Taxes imposed on sellers raise the negotiated house price whereas taxes on buyers lower it. The magnitude of the price effects depends on the vacancy rate.

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It is often claimed in the public debate that taxation in the owner-occupied housing market has detrimental welfare effects, particularly in the form of substantial lock-in effects. Not only would these taxes distort the housing market, but, maybe more importantly, they might also decrease flexibility in the labor market. This was a major reason why the Swedish government in the latest tax reform decided to abolish the capital gains taxation on housing for any transaction that involved a move to another house or condominium.

However, the effects of taxation in the housing market and the lock-in effects have received only little attention in the literature. Studies by Englund (1985, 1986) are, however, exceptions. He analyses dynamic models in which the household chooses between housing and other consumption. It is shown that it is not generally true that capital gains taxation creates lock-in effects, if one assumes an infinite horizon and the possibility for the households to deduct other transaction costs.¹

This paper studies housing market taxation in a model that is quite different from Englund's. In the housing market, like in the labor market, search, matching and vacancies are crucial concepts and a search model is therefore appropriate for the analysis of housing taxation. Wheaton (1990) presented a search model of the housing market and we extend his model by allowing for taxes imposed on sellers and buyers in the market. While the Wheaton model rests on some highly simplifying assumptions which limit its realism, it nevertheless has proven to yield reasonable relations between prices, vacancies, search effort etc. We show that it also is useful for understanding the effects of housing taxation.

The housing market is characterized by high transaction costs and capital gains taxes and recording fees are, of course, not the only ones. Non-price rationing costs of rents and mortgage credits, costs of acquiring information due to spatial fixity and heterogeneity of housing, e.g. brokerage and agent fees, legal fees, mortgage refinancing costs, and moving costs due to transportation,

¹Empirical evidence on the issue is almost non-existent. See Lundborg and Skedinger (1995).

refurnishing, and the break-up of neighborhood attachments are other major transaction costs. These costs generally inhibit mobility as adjustment of housing consumption in general requires a move.

One should distinguish between fixed transaction costs and transaction costs that are proportional to the house value. We specify the tax in the latter way, which roughly corresponds to the manner in which seller's taxes (capital gains taxes) and buyer's taxes (e.g. recording fees) are actually set in the housing market. Thus, the tax base in the model is not the capital gains but rather the negotiated price. The model, unless complicated beyond tractability, only allows this type of tax to be analyzed. It captures, though, a crucial element of taxation, namely the transaction cost element of the tax. We want to illuminate how taxes on sellers and buyers affect the matching rate, search effort and house prices and how mobility in the housing market is affected.

We argue that Wheaton's search model is a useful tool in understanding taxation in the housing market but that it is necessary to impose further restrictions on the model than those stated in his original study. Having specified the restrictions we show the following:

- i. Taxes, imposed on sellers or buyers, create lock-in effects through reduced search effort and matching rates. As such, they lower welfare since the difference between the privately and socially optimal search effort is increased.
- ii. A socially optimal policy is to subsidize house transactions. The private level of search is below the one in social optimum since only buyers search but both buyers and sellers gain from search. The optimal subsidy rate increases in the number of vacancies.
- iii. The tax effects are not symmetric. The price response crucially depends on whether buyer or seller is taxed; a buyer's tax lowers the price and a seller's tax raises the price. Moreover, a seller's tax creates larger

lock-in effects than a buyer's tax.

Like Wheaton, we obtain our results by simulations and it should be noted that there are great uncertainties involved, particularly as the parameter values in search models typically are unknown. We believe that the value of the simulations lies mainly with the qualitative effects of the taxes while the quantitative results should be handled with care.

I A Search Model of the Housing Market.

In this section we set out the model developed by Wheaton (1990) and introduce taxes. We also discuss the restrictions that must be imposed on the model. Our presentation of the Wheaton model is rather rudimentary, so the reader is referred to the original article for further details.

Households become mismatched at an exogenous rate in the model and they search for new housing that better suits their needs. The utility of being in the mismatched state determines house prices and individuals' search effort. A characteristic of the housing market is that there is a spell in which households own (or rent) two units. Anyone who sells is therefore also a buyer who has found a new unit and wants to dispose of the old one. Expectations about sales times and costs of holding double units determine the reservation price. In such a setup, more vacancies increase sales times and search times while lowering seller's reservations and market prices.

The expected price of a house is simply the market price discounted by expected sales time. The thus determined expected price will, in the long run, equal the marginal cost of the new units that are added to the competitive supply. At this point the vacancy rate has reached its "structural" rate.

In the model, the individual household is either matched or mismatched which is the result of the assumption of two household types (e.g. families or singles) and two types of units (e.g. large and small). Any household is matched if it resides in the appropriate unit, i.e. it is matched also if it owns two types. If

the household lives in one unit only which is of the wrong type (e.g. a family living in a small unit) the household is mismatched.

Households change status, due to marriage, child birth, income increases etc. and in changing status they also are mismatched as long as they remain in the same unit. Households become matched by purchasing another unit. They will then put up their old unit for sale and for a spell occupy two units.²

Let the rate of change from household type 1 (type 2) to type 2 (type 1) be labeled β_1 (β_2) and H_i ($i=1,2$) the total number of households of type i . We then have, with overdots representing time derivatives:

$$\dot{H}_1 = \beta_2 H_2 - \beta_1 H_1, \quad (1)$$

$$\dot{H}_2 = \beta_1 H_1 - \beta_2 H_2, \quad (2)$$

from which it follows that

$$\frac{H_1}{H_2} = \frac{\beta_2}{\beta_1}. \quad (3)$$

Any household can be in one of three occupancy states; matched with one unit of type i (HM _{i}), matched with two different units (dual) (HD _{i}), and mismatched (or separated), i.e. living in a unit of the wrong kind, (HS _{i}). As a household switches from type 1 to 2 or from type 2 to 1 it becomes mismatched and looks for a vacant house of the other kind and when one is found the move is immediate. Then the old house is vacant, i.e. for sale, and the household is in the dual ownership state (HD _{i}). When the old house is sold the household

²In the Swedish housing market, it has in the recent times of tight credit markets become common for households to first sell their own unit conditionally on their own finding a new unit to live in. But also in this case will the individual household occupy two units for some time.

returns to the single matched state (HM_i).

In the short run, the stock of housing is fixed and is greater than the number of households; vacancies are simply the difference between units and households:

$$V_i = S_i - H_i > 0, \quad (4)$$

for $i = 1, 2$ and where V_i is vacancy of type $i=1, 2$ and S_i is the stock of units of type i . Those mismatched cannot immediately find an appropriate house which is the basic reason for the uncertainty in the model.³ The matching between mismatched households and vacant units occurs with a Poisson process. The parameters underlying the process are the rates at which homes of that type are found (m_1, m_2). These will later be determined by the buyers' decision on search effort. The aggregate flows of new house purchases are $m_i HS_i$ ($i=1, 2$). The sales rate of vacant homes will also occur with a Poisson process whose parameters (q_1, q_2) are determined to equalize the flow of purchases with sales:

$$q_i = \frac{m_i HS_i}{V_i}. \quad (5)$$

With a fixed number of households and units of each type, the following differential equations characterize the move of the households and state changes:

$$\dot{H}S_i = -m_i HS_i - \beta_i HS_i + \beta_j HM_j \quad (6)$$

$$\dot{H}D_i = -q_j HD_i + m_i HS_i + \beta_j HD_j - \beta_i HD_i \quad (7)$$

³In a two house type model this might seem as a minor problem but this assumption is only made for analytical convenience and the generality remains.

$$\dot{HM}_i = -HS_i - HD_i \quad (8)$$

for $i \neq j$. A further assumption that reduces this equation system is that the two types of households are identical in number and behavior. If $\beta_1 = \beta_2$, $V_1 = V_2$, $H_1 = H_2$ and $m_1 = m_2$ one obtains perfect symmetry in the model with $HS_1 = HS_2$, $HM_1 = HM_2$ and $HD_1 = HD_2$. Then the subscript representing household type can be dropped and the system reduces to

$$\dot{HS} = -HS(2\beta + m) + \beta H - \beta HD, \quad (9)$$

and

$$\dot{HD} = mHS(1 - \frac{HD}{V}). \quad (10)$$

HS and HD are determined by (9) and (10) and the number of matched households owning one unit, HM, is found by subtracting HS and HD from the total number of households H. The steady state is then

$$HS = \frac{\beta(H-V)}{2\beta + m}, \quad (11)$$

and

$$HD = V. \quad (12)$$

The expected time to sell a unit is $1/q = L$, or

$$L = \frac{V(2\beta + m)}{\beta m(H-V)}. \quad (13)$$

Until now, we have assumed that matching and sales rates are given. It is

more realistic to assume that these parameters are determined by search effort. In Wheaton's model, the search technologies are of two different kinds. If some imperfections appear in the advertisements of the type of unit that is offered for sale, search effort would equal the number of visits per period. With a .5 likelihood of finding the right unit on a visit, the matching rate m would equal $E/2$, where E is search effort. If advertising is impossible, a unit's vacancy would also have to be identified. Any visit then implies a likelihood of $V/2S$ of finding both a vacancy and one of the right type, and the matching rate would equal $EV/2S$. While the technology $E/2$ is unaffected by the number of vacancies, this latter case may be called "productive" vacancies as greater vacancy raises the productivity of search.

As the symmetry assumption has been imposed, implying that a type 1 household derives the same utility as type 2 household of being matched or mismatched, we need only consider the decision of one type of household. The flow of utility of residing in a matched house is then UM and in a mismatched state it is US .

Using the asset market equilibrium condition, we may determine the present discounted value of being in each of the three occupancy states. The equations (14) through (16) below state that the return from being in each state must equal the utility flow associated with that state plus any capital gains or losses from changing states. We now depart from Wheaton's original setup as we introduce taxes, proportional to the house value, in the model. We then have:

$$rWM = UM - \beta(WM - WS), \quad (14)$$

$$rWD = UM + q[WM - WD + R(1 - \tau_d)], \quad (15)$$

$$rWS = US - c(E) + \beta(WM - WS) + m(E)[WD - WS - R(1 + \tau_s)], \quad (16)$$

where : WM, WD, WS = the present values of each state (matched with one home, matched with two homes and mismatched);
 UM, US = utility flows if matched and mismatched, respectively;
 r = rate of discount;
 c(E) = cost of searching with effort level E;
 β = the transition rate between the two household types;
 m(E) = the matching rate with effort level E;
 q = the sales rate;
 R = the market price for a house;
 τ_d = seller's tax rate, and
 τ_s = buyer's tax rate.

What do these equations tell us? Equation (14) states that the annual return from being in a matched state with one house equals the utility flow associated with that state minus the probability of becoming mismatched times the utility loss when moving from a matched state, WM, to a mismatched, WS.

Equation (15) says that the annual return from being matched with two houses equals the utility flow of being matched plus the utility gain when the household sells the old unit, which involves a capital gain, i.e. the house price net of seller's tax, $R(1-\tau_d)$.

Note that the tax we analyze represents a special kind of tax since it is the price, rather than the increase of the price during the owner's period of residence, that is being taxed.⁴ Only this type of tax, i.e. one that affects those buying up and those buying down in an identical way, is possible to analyze in the model.

Finally, (16) states that the return from being mismatched is equal to the flow of utility of being in that state, plus the expected gain if the household

⁴This type of tax, i.e. one which is expressed as a share of the price, is part of housing taxation in for instance Sweden.

changes back to being matched plus the expected search gain which consists of search costs $c(E)$, the price to be paid for the house, R , and the taxes that are imposed on the buyer, τ_s . Both units have the same market price as utility flows derived from each state are symmetric.

How is the price determined? Since both seller and buyer are identical one should assume that the bargaining power is equal and that they split the gains from the transaction equally. Allowing for the taxes we have $WM - WD + R(1 - \tau_d) = WD - WS - R(1 + \tau_s)$, or:

$$R = \frac{WD - WS + WD - WM}{2 + \tau_s - \tau_d} \quad (17)$$

The costs of owning a second house are the postponed receipts of $R(1 - \tau_d)$. Households choose the search effort so as to maximize the value of being mismatched, which requires that they search until the marginal gain from the last unit of search effort is equal to cost of that marginal unit. The relevant condition is obtainable from (16) as:

$$\frac{\partial c}{\partial E} = \frac{\partial m}{\partial E} [WD - WS - R(1 + \tau_s)], \quad (18)$$

where the term in brackets represents the utility level of being matched.

With the equations (14) through (18) and the definition of q in equation (5) (or L in equation (13)) we may solve for the six unknowns WM , WD , WS , R , q (or L) and E . The solution hinges on search technology, represented by the c and m functions, the turnover rate β and, finally, the vacancy rate, V/S . The equations (14)-(18) can be solved in terms of differences in the state values. Subtracting (16) from (14) and incorporating (17) yields:

$$WM - WS = \frac{UM - US + c(E) - m(E)[WM - WD + R(1 - \tau_d)]}{2\beta + r} \quad (19)$$

Equation (19) expresses the net gains of moving from being mismatched to

being matched with one house (after meanwhile having been in a state of owning two houses). The net gains when moving from a mismatched state to being matched with two houses (net gains to buyer) and the net gains when moving from being matched with two houses to being matched with one, i.e. net gains to a seller, are obtained in the following way.

By subtracting (15) from (16), combined with (17) and (19), we obtain the net gains to a house purchaser as:

$$WD - WS - R(1 + \tau_b) = \frac{1}{Z - \beta m(E)} [(UM - US + c(E))(\beta + r) - rR(1 + \tau_b)(2\beta + r)], \quad (20)$$

where $Z = [r + m(E) - q](2\beta + r)$. Similarly, the net gains to a house seller are obtained as:

$$WM - WD + R(1 - \tau_s) = \frac{1}{X - \beta m(E)} [-\beta(UM - US + c(E)) + rR(1 - \tau_s)(2\beta + r)], \quad (21)$$

where $X = (q + r)(2\beta + r)$.

Equating (20) and (21) yields a solution for R as a function only of E and the other system parameters:

$$R = [UM - US + c(E)] \left\{ \frac{2\beta + r + q}{r[4\beta + 2r + m(E)] + \tau_b(X - \beta m) - \tau_s(Z - \beta m)} \right\}. \quad (22)$$

Equation (22) states that, at constant search effort and if $X - \beta m(E)$ and $Z - \beta m(E)$ are positive, the effect on the house price of an increase in the buyer's tax (τ_b) is negative while it is positive of an increase in the seller's tax (τ_s). An increase in the buyer's tax lowers the buyer's utility but since the price is set so as to equalize utility levels across buyers and sellers, the price will have to fall. This price fall benefits the buyer and, at the same time, hits the seller negatively. The

same reasoning holds for the seller's tax. An increase lowers seller's utility but the price rises to compensate the seller and this price hike in turn lowers the buyer's utility. We note, however, that it is of no concern to either party what type of tax is imposed. Note also that if $\tau_a = \tau_s = 0$, we are back into the original Wheaton model. In Section II, where we apply the model, we will also evaluate the steady state results when search effort adjusts.

Incorporating (22) into both (20) and (21) we get the net gains to each party, solely as a function of E and the system parameters. We express this in terms of the purchaser's net gains⁵:

$$\frac{WD - WS - R(1 + \tau_s)}{(Z - \beta m)} \left[\beta + r - \frac{r(1 + \tau_s)(2\beta + r)(2\beta + r + q)}{r(4\beta + 2r + m) + \tau_s(X - \beta m) - \tau_d(Z - \beta m)} \right]. \quad (23)$$

Combining (23) with (18) gives the privately optimal search rule as an implicit function only of E and the system parameters:

$$\frac{\partial m}{\partial E} \frac{[UM - US + c(E)]}{(Z - \beta m(E))} \left[\beta + r - \frac{r(1 + \tau_s)(2\beta + r)(2\beta + r + q)}{r(4\beta + 2r + m) + \tau_s(X - \beta m) - \tau_d(Z - \beta m)} \right] = \frac{\partial c}{\partial E}. \quad (24)$$

The system is now recursive: Given functional forms for c and m , equation (24) is first solved for E , and with (13), this solution determines q and L , from which all prices and present values can be obtained with (21)-(23).

The social welfare function is defined as the present discounted value of aggregate utility net of search costs. The welfare function is derived by posing the question if the discounted value of utility can be increased by adjusting search effort as utility moves along an adjustment path from the market steady state to this welfare-improving steady state. Welfare is then an integral:

⁵We could also have expressed it in terms of seller's net gains, and in that case τ_a would have appeared in the numerator of the last term in equation (23).

$$W = \int e^{-rt} [HS(US - c(E)) + (H - HS)UM] dt, \quad (25)$$

where t represents time. To answer the question if welfare can be improved by changing the privately determined search effort level, one needs to take the derivative of W with respect to E and incorporate (9) and (10). This yields (see Diamond (1980)) the following derivative when evaluated at the initial market steady-state solution:

$$\frac{\partial W}{\partial E} = \frac{HS}{r} \left[-\frac{\partial c}{\partial E} + \frac{\partial m}{\partial E} \frac{UM - US + c(E)}{2\beta + r + m(E)} \right], \quad (26)$$

The term in parentheses can be shown to be identical to the private search condition (24) (at $\tau_s = \tau_d = 0$), except that the denominator is $2\beta + r + m$ rather than $4\beta + 2r + m$. This, in turn, implies that welfare is improved with further search since $dW/dE > 0$.

Another important issue concerns the notion of the long-run optimal vacancy rates. The expected price must then be such that r times that value equals the probability of a sale times the gains from a sale. This gives us:

$$R^e = \frac{R}{(1 + r/q)}, \quad (27)$$

which is the market price discounted by the expected length of sale. The socially optimal rule for search effort,

$$\frac{\partial c}{\partial E} = \frac{\partial m}{\partial E} \left(\frac{UM - US + c(E)}{2\beta + r + m(E)} \right), \quad (28)$$

holds if all the gains to search accrue to the buyer, i.e., $R = WD - WS$.

As we carry out a tax analysis, we need to derive some additional variables which were not considered by Wheaton. Tax revenues are given by

$$G = R(mHS \tau_s + qV \tau_d), \quad (29)$$

which says that tax revenues are determined by two flows: The number of mismatched households (HS) becoming matched with two units, paying the purchase tax, plus the number of households with dual ownership, HD , (which equals the number of vacancies in steady state), who will sell their house and pay a seller's tax. From (5) it follows that in steady state, $mHS = qV$, implying that $G = RqV(\tau_s + \tau_d)$.

To obtain the excess burden of the tax, EB , we follow Atkinson and Stiglitz (1980) and obtain

$$EB = \int_{q^0}^{q^\tau} R(1 + \tau_d + \tau_s) V dq - RV(q^0 - q^\tau) = RV(q^0 - q^\tau)(\tau_d + \tau_s), \quad (30)$$

where the superscript 0 denotes variables evaluated in the absence of taxes and superscript τ denotes variables evaluated at positive taxes. The excess burden thus consists of the value of all vacant houses (RV), times the decrease in sale rates ($q^0 - q^\tau$) times the sum of the tax rates.

Restrictions on the Model

We argue below that economic as well as technical considerations imply that restrictions should be imposed on the model and that Wheaton evaluated the model at unreasonable parameter setups. These restrictions are that the denominators $Z - \beta m(E)$ and $X - \beta m(E)$ in equation (20) and (21) respectively, are positive. We first present economic arguments for these restrictions and then show that at certain vacancy rates there do not exist prices that solve the model. We finally demonstrate that the model yields nonsensical adjustments to the taxes if the restrictions are not imposed.

First, consider (20) in which $Z - \beta m(E)$ is the denominator. Clearly, the net gains to the house buyer can be subdivided into two terms. The first represents the discounted value of the utility gains the purchaser experience as he moves from a mismatched state to being matched (with two houses).⁶ Assuming

constant search effort, consider an increase in the of utility of being matched, UM . Evidently this should benefit the buyer, but it will do so only if $Z-\beta m(E)$ is positive. The second term represents the monetary costs of the house, including the tax. Consider an increase in the tax. The individual buyer's net gain should fall as the price goes up. This intuitive result only occurs if $Z-\beta m(E)$ is positive. Clearly, if the model is to yield intuitive results under constant search effort it must be evaluated under the restriction that the common denominator in (20), $Z-\beta m(E)$, is of a positive sign.⁷

Now consider equation (21). Since buyer's and seller's utilities are equalized also seller's net gain is expressed in terms of $UM-US+c(E)$ and the first term in (21) must therefore be of the opposite sign to the first term in (20), i.e the seller's utility of giving up one house must be negative. This is so only if $X-\beta m(E)$ is positive. Consider the second term; if $X-\beta m(E)$ is negative a seller's tax increase will *raise* the seller's net gains at constant search effort.

In Wheaton's simulations the restrictions $Z-\beta m(E) > 0$ and $X-\beta m(E) > 0$ have not been imposed. In his second example, which covers the span of vacancy rates from 0 to 20 per cent, it is only at vacancy rates larger than 8.2075 per cent and smaller than 10.3194 that both restrictions are fulfilled. With the parameter values used by Wheaton and at vacancy rates below 8.2075, $Z-\beta m(E)$ is negative and above 10.3194 per cent, $X-\beta m(E)$ is negative. Hence, there is a lack of economic sense for the vast majority of reasonable vacancy rates as discussed above.

As the denominators switch signs it follows that equilibria do not exist along the whole range of vacancy rates. With Wheaton's parameter values and at the vacancy rate 8.2075, $Z-\beta m(E)$ is zero. This can be seen by plugging in his parameter values and the values of the endogenous matching rate, m and

⁶Here, $c(E)$ enters which is a recognition of the fact that the buyer leaves a state of being mismatched which, as noted above, involves a search cost to become matched (eq. (16)).

⁷The price of the house would also be affected by an increase in UM . But note that a price *increase* would be required for the net gains to be affected positively with a negative denominator. This is clearly counter-intuitive and, hence, two unreasonable effects are necessary to generate a reasonable effect on net gains.

sales rate, q in this expression.⁸ Moreover, at this vacancy level also the numerator is zero so that we have:

$$(\beta+r)[UM-US+c(E)]=rR(2\beta+r). \quad (31)$$

(We set taxes to zero as in Wheaton (1990).) The price should adjust to equalize purchaser's and seller's net gains. But, at this point where $Z-\beta m(E)=0$, the denominator in the equation representing seller's net gain, i.e. $X-\beta m(E)$, is positive and for the net gains to be zero also for the seller the numerator must be zero. This requires that

$$-\beta[UM-US+c(E)]=rR(2\beta+r). \quad (32)$$

But obviously, there does not exist a price such that both (31) and (32) are simultaneously fulfilled. Consequently, an equilibrium at the vacancy rate 8.2075 does not exist.

Moreover, at a somewhat higher vacancy rate, 10.3194 per cent, $X-\beta m(E)$ is zero. The parameter values also imply that the net gains to the seller in (21) are zero, i.e. (32) holds. Can a price be found that equalizes net gains? At this vacancy rate, $Z-\beta m(E)$ is positive and for the price to equalize net gains also the net gains of the buyer must be zero. This requires that (31) is fulfilled but it cannot be if (32) is. Hence there is another vacancy rate for which the model, as implemented by Wheaton, does not have a solution. Consequently, it is not justified to draw Fig. 4 in Wheaton (1990).

These results further point towards the restrictions that must be fulfilled for the Wheaton model to be implemented and add formal problems to the more intuitive arguments that are related to the signs of $Z-\beta m(E)$ and $X-\beta m(E)$. However, these complications should not be looked upon as a basic criticism of the Wheaton model. On the contrary, if the proper restrictions are imposed, we shall show that the model does yield new and interesting insights concerning the effects of taxation on housing.

⁸Wheaton assumed $\beta = .1$, $r = .05$, $UM = 10\ 000$, $US = 5\ 000$, $c_0 = 2.50$ (see later in the text) which, at $V = 8.2075$ yields a matching rate of 1.40 and a sales rate of .89.

II Applications

Before we present the effects of taxation, it is useful to consider some other mechanisms in the search model. We specify the search technology as:

$$m = (1/2)\alpha E^\theta (V/S)^\gamma, \quad (33)$$

which is a generalization of Wheaton's "productive vacancy" matching technology.⁹ We interpret E as the value, in hours and money spent, of search in the housing market per time period. This may represent any type of search effort like buying and reading advertisements, visiting houses, talking to friends etc. The matching rate, m , is the number of matches during the same period and V/S is the vacancy rate. As in Wheaton (1990), $1/2$ in (33) appears as there are only two types of houses and the parameter α measures the information efficiency: given the search activity of buyers and the vacancies this parameter measures the degree to which information is spread across sellers and buyers. This could represent the number of newspapers per household, social networks etc.

We assume the following parameter values: $\alpha = 1$, $\theta = .55$ and $\gamma = .45$ and these values give consistent and feasible values for any tax and vacancy rate which we consider to be of interest to study. The empirical values of these parameters are, though, unknown. The chosen γ and θ - values imply that we assume constant returns to scale in the matching function. (Wheaton, in his second example, assumed increasing returns as $\gamma = \theta = 1$.) We specify the cost function in the same way as Wheaton, i.e. $c = c_0 E^\alpha$.

Above, we have discussed extensively the restrictions that $Z - \beta m(E)$ and $X - \beta m(E)$ both should be positive. To fulfill these restriction one can either raise the rate of interest or, β , the rate of change from one state to another. We assume $r = .07$ and set $\beta = .01$ (which is one tenth of Wheatons parameter value). These parameters fulfill the restrictions at the vacancy rates 2 to 12 per cent which we consider cover a relevant range of "loose" and "tight" housing

⁹See Wheaton (1990), p 1288.

markets. One should note that a low β -value is also a reasonable consequence of the fact that there only exists two types of houses (e.g. small and large). We should expect the probability of becoming mismatched with the wrong house to be very small. The likelihood of being mismatched is, of course, much larger if there is a continuum of house sizes and qualities. As concerns the other parameter values, we assume the same values as Wheaton does, i.e. $c_0 = 2.5$, $\mu = 2$, $UM = 10\ 000$ and $US = 5\ 000$.

Taxes, prices and matching rates

To further show the necessity of the restrictions it can be demonstrated that if they are not imposed, taxes produce effects that are not reasonable. Fig 1 shows the price effects under Wheaton's parameter setup.¹⁰ We consider the effects of a 3 per cent increase in seller's and buyer's taxes, respectively.¹¹ At low vacancy rates the negotiated price drops. Consider a 3 per cent increase in the seller's tax, τ_s . While we should expect a small price increase we find that, at a vacancy rate of 1 per cent, the tax produces a 45 per cent price fall! Only at very high vacancy rates, where $Z - \beta m(E)$ is positive, does the model yield reasonable effects of the tax. For instance, at vacancies around 10 per cent the price rises by 2 per cent.¹²

The responses to a buyer's tax are similarly perverse as $X - \beta m(E)$ is negative. At high vacancy rates, where $X - \beta m(E)$ is negative, a buyer's tax actually raises the price. At lower rates, where $X - \beta m(E)$ is positive, the tax produces an expected fall in the price. But, in general, the effect is implausibly large. For instance, the 3 per cent tax on the buyer at a 2 per cent vacancy rate lowers the price by 42 per cent! Only around the very high vacancy rate of 10 per cent is the tax effect qualitatively and quantitatively reasonable and here the

¹⁰We show Fig 1 for illustrative reasons, but, like Wheaton, we are not justified in drawing lines at vacancy rates 8.2075 and 10.3194.

¹¹A seller's tax of 3 per cent of the house value roughly corresponds to observed rates in the Swedish housing market. See Lundborg and Skedinger (1995).

¹²Note that a positive $Z - \beta m(E)$ does not guarantee a price effect of the expected sign.

3 per cent tax lowers the price by 1 per cent. At higher vacancy rates, where $X - \beta m(E)$ is negative, the tax raises the price which is hardly reasonable.

Turning to our simulations in which the restrictions discussed have been imposed, we first study the effect of taxes on effort, matching rates and sales length (See Table 1). As before, we consider the effects of a 3 per cent increase in buyer's and seller's tax, respectively. Both taxes have very similar effects on search effort. At each vacancy rate, effort falls as a result of the tax as it lowers the return from searching. But it is noteworthy that the effort reduction is much larger, in relative terms, at low vacancy rates than at high. The basic reason for this is that a tax has a much larger impact on the net gains of a house deal at tight housing markets. The price increases in the vacancy rate, while net gains do not change much across vacancy rates (e.g. UM and US are constants). Consequently, the price is much more important to the net gains at low vacancies than at high. Consider an increase in the buyer's tax at low vacancies, i.e. at a high price. Since a high price implies large tax payments, his net gains and effort fall quite much. At high vacancies, the price is low and the buyer's effort is reduced only modestly.

The effects of the seller's tax are similar. At low vacancies, the seller's net gains are affected a great deal and so are the buyer's who reacts by lowering effort much. At high vacancies, the price is low and net gains are affected only slightly so that the buyer only lowers effort marginally. The effects of a seller's tax is, however, somewhat larger than the effects of a buyer's tax.

What can we say about the often alleged lock-in effects of housing taxation? It can be noted in Table 1 that higher taxes always decrease matching rates, which in turn reduces welfare. Welfare is in (25) the added sum of the utilities of the mismatched and the matched households and since the utility of the former is lower than of the latter, an increase in the number of mismatched lowers welfare. Hence, there are lock-in effects of the taxes in the sense that a smaller number of households move during a given period. We also see in Table 1 that as search and matching rates fall with the taxes, the expected sale lengths rise. Also here is reflected the importance of the initial effect of the tax on

search effort in that the sale lengths rise the most at low vacancies, i.e. where effort is affected the most.

Table 1. Per cent changes in search effort, matching rates and sales length of 3 per cent tax increases.

Vacancy rate, %	Search effort		Matching rate		Sales length	
	τ_s	τ_d	τ_s	τ_d	τ_s	τ_d
2	-2.20	-2.26	-1.21	-1.25	.050	.051
3	-1.36	-1.40	-.75	-.77	.025	.026
4	-.98	-1.01	-.54	-.55	.016	.016
5	-.76	-.78	-.42	-.43	.011	.011
6	-.62	-.64	-.34	-.35	.008	.009
7	-.53	-.55	-.29	-.30	.007	.007
8	-.46	-.48	-.25	-.26	.005	.006
9	-.41	-.42	-.22	-.23	.004	.005
10	-.37	-.38	-.20	-.21	.004	.004
11	-.34	-.35	-.18	-.19	.003	.003
12	-.31	-.32	-.17	-.18	.003	.003

So far we noted that the two taxes have very similar effects. As we turn to the effects on the price we first see in Fig 2 that, as expected, the two taxes have qualitatively different effects. Most importantly, we now find that taxes yield effects of reasonable magnitude across all vacancy rates.

An interesting finding is also that the quantitative effects of the two taxes differ greatly. While the effects of seller's taxes are relatively small at low vacancies and large at high vacancies, the opposite holds for buyer's taxes. These differing effects can be understood by inspection of (22) and by noting that $Z-\beta m(E)$ increases and $X-\beta m(E)$ decreases in vacancy rates. Consider an

increase in the seller's tax, τ_d . At low vacancy rates, the price is high. As the seller tries to compensate for the tax by asking for a price increase, the buyer resists since the marginal effect on his net gains is large. This is manifested in a small value of $Z-\beta m(E)$ at low vacancies. At high vacancies, where the price is of a minor importance to the buyer the seller is able to compensate more easily for the tax since the marginal effect for the buyer of a price increase is lower. This is represented by a high value of $Z-\beta m(E)$ at high vacancy rates.

When the buyer's tax, τ_b , is increased, the purchaser's net gains fall and he must be compensated with a lower price. At low vacancies, the seller can accept a relatively large price fall since the price is high and the marginal effect of a price fall is relatively low. This is represented by the value of $X-\beta m(E)$ being large at low vacancies. At high vacancies, though, it is more difficult for the buyer to get compensation via a lower price since the price already is low and the marginal effect on the seller is relatively larger. This is represented by a relatively small value of $X-\beta m(E)$. Clearly, if $Z-\beta m(E)$ or $X-\beta m(E)$ are assumed negative, the model will yield unreasonable adjustments to the changing parameters.

A major point in Wheaton's article is that, with productive vacancies, the price first increases in vacancies, reaches a maximum and then decreases. (See Wheaton (1990) Fig. 4.) While such shapes do not crucially hinge on the restrictions, we have nevertheless been unable to reproduce the shapes at any vacancy rate and at any reasonable parameter values after the restrictions were imposed. We therefore conclude that, though theoretically possible, the probability that the price should increase in vacancies is low.

Taxes, government revenues, and welfare

It should not come as a surprise that the tax revenues that the government collect depend on the price level. Prices vary considerably with vacancy rates, from 75 000 at 2 per cent vacancies to 11 000 at 12 per cent vacancies. Therefore, tax revenues differ across vacancy rates, which we see in Fig 3, where, for the 3

per cent tax rate, revenues change drastically. For instance, a seller's tax yields tax revenues of 20.76 at a 2 per cent vacancy rate, but this figure falls to 2.51 at a 12 per cent vacancy rate. A buyer's tax of the same magnitude has very similar effects on tax revenues. The buyer's tax, though, always yields lower tax revenues than the seller's tax which is a result of the fact that the buyer's tax lowers the price and seller's tax raises it.

Turning to the welfare effects, we see in Fig 4 that the seller's tax raises the excess burden more than the buyer's tax does. From (30) it follows that, for given tax rates and vacancy rates, the excess burden is given by the price level (since this determines the value of all vacant houses) and by q , the sales rate. First, the seller's tax raises the price which adds to the excess burden as the value of the vacant houses then rises. However, an effect in the opposite direction is that the sales rate falls more in the case of a seller's tax which is a direct consequence of the fact that search effort falls more by the seller's tax than by the buyer's tax. The falling sales rate tends to make the effects on the excess burden larger from increases in the buyer's tax. The net effect is, for any vacancy rate, that the excess burden is larger with the seller's tax.

A notable effect is that, for both taxes, the excess burden is inversely related to the vacancy rate. Three mechanisms are involved. First, the number of vacancies *per se* tends to make the excess burden larger at high vacancy rates. This effect, however, is counteracted by the fact that the price falls drastically with the number of vacancies. Finally, the effects of the taxes on sales rates are considerably lower at high vacancy rates. This tends to make the effects on the excess burden larger at low vacancy rates. The net effect of these three forces is clear for both taxes: the negative welfare effects of the taxes are larger at low vacancy rates.

Subsidies and the optimal search effort

Wheaton (1990) noted that the socially optimal search level is higher than the one which the model generates. The basic reason is that the search which the

house buyers conduct also favors the sellers. Since only the buyers search, the private search intensity is less than the socially optimal one.

The introduction of taxes into the model tends to further lower search effort and increase the difference between the private and socially optimal search effort. To reach the socially optimal search effort, one should, instead, introduce subsidies which raise search effort. Since the buyer does all the search in the model we focus on subsidies to the buyers. (A socially optimal level of search can, however, also be obtained with subsidies to the seller but this requires larger subsidies.)

It turns out that the level of the optimal subsidy varies considerably across vacancies, ranging from 13 per cent of the house value at a 2 per cent vacancy rate to 49 at a 12 per cent vacancy. Just as taxes affect effort more at low vacancies, so do the subsidies. At a low vacancy rate the price is high and if, as we assume, the buyer's subsidies depend on the magnitude of the price (which we assume by our *ad valorem* subsidy) the net gains are strongly affected by the subsidy and hence the buyer increases effort relatively much. At high vacancies, though, the price is low and a given rate of the *ad valorem* subsidy has a smaller impact on net gains and hence the buyer increases effort only little. Clearly, if the reactions to a given subsidy rate is strong at low vacancies and weak at high, the optimal subsidy rate will be small at low vacancies and large at high vacancies.

III Conclusions

We have demonstrated that a search model is useful in order to gain insights into the consequences of housing market taxation. We have spelled out the restrictions which are necessary for the model to yield consistent and reasonable effects. After having imposed the restrictions we show that the seller's tax always raises the price within the vacancy rates we consider to be relevant in the housing market. A seller's tax lowers the seller's net gains of a house deal and since the price is set in negotiations to equalize buyer's and seller's net gains, also buyer's net gains drop. This in turn implies a price increase. The extent of

this price increase depends on how sensitive the buyer's net gains are to a price increase and this sensitivity varies across vacancy rates.

That a seller's tax raises the price is a result obtainable also in models in which search does not take place.¹³ However, we are also able to evaluate the effects of taxes on the buyer, e.g. recording fees, and we show that such a tax always lowers the price level. The buyer's tax reduces the net gains of the buyer and since the net gains of the seller also should fall, the price must come down. The extent of this price decrease depends on how sensitive the seller's net gains are to a price decrease and, as for the seller's tax, this sensitivity varies across vacancy rates.

Both taxes discourage search efforts since the net gains of buying a house fall. This reduction lowers the matching rate which may be interpreted as if the taxes create lock-in effects in the housing market. The taxes increase the difference between the private search effort and the socially optimal search effort and the remedy would rather be a subsidy. The optimal subsidy rate depends positively on the vacancy rate. It can be noted that capital losses in the housing market may be deducted from taxable income in many tax systems (e.g. the Swedish), a rule for which we thus have provided an economic rationale in this paper.

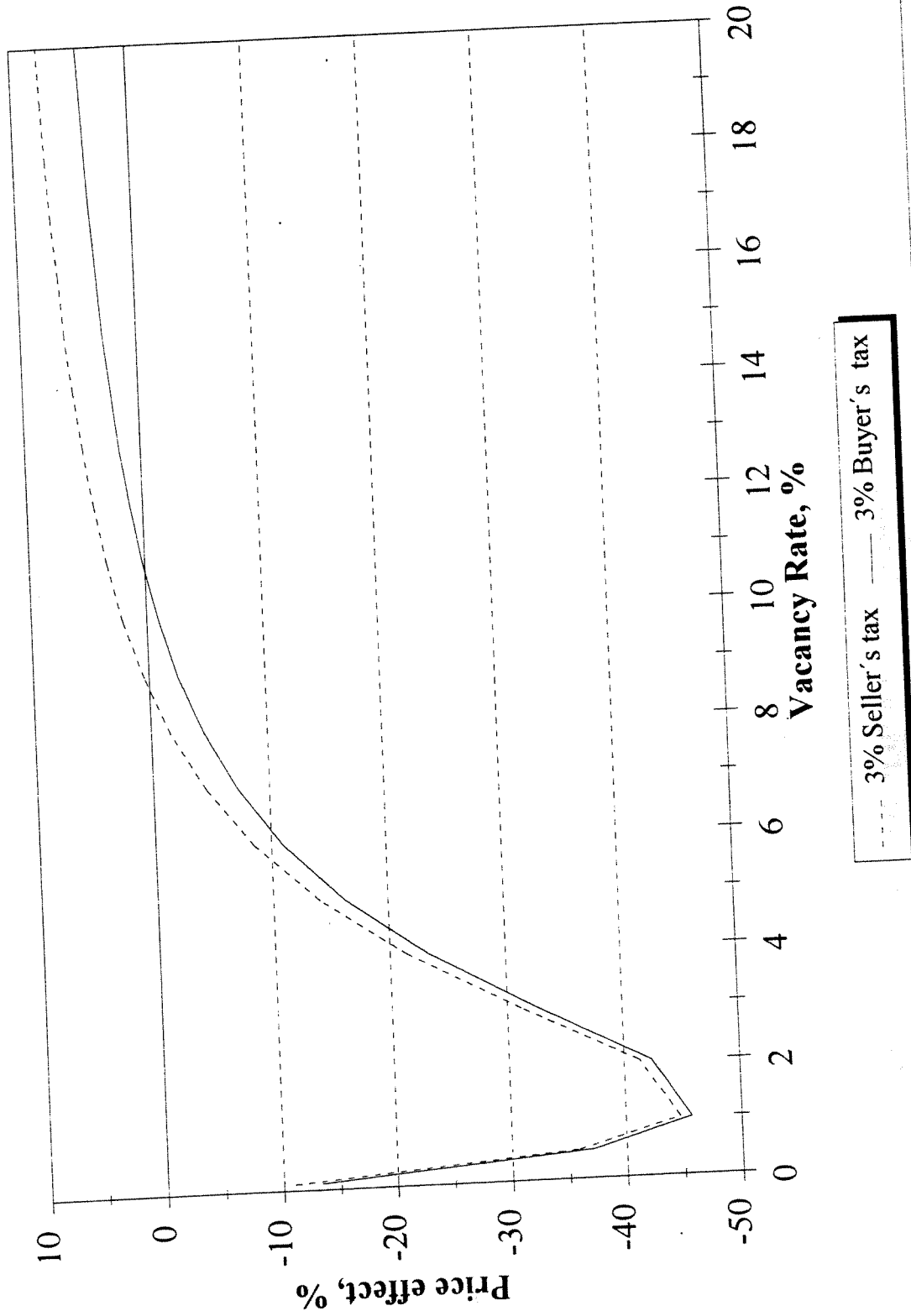
The numbers we obtain should be treated with care due to the obvious simplifications on which the model rests. We have, for instance, not considered the effects of fixed transaction costs which typically characterize housing markets. Still, we believe that we have captured the crucial mechanisms involved in the adjustments to taxes and subsidies in a search model of the housing market.

¹³See Englund (1985, 1986).

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**Fig 1. Effects of taxes on prices with parameter values as in Wheaton (1990).
Per cent changes compared to no tax solution.**



**Fig 2. Effects of taxes and prices. Restriction imposed ($Z - \beta m > 0$ and $X - \beta m > 0$).
Per cent changes compared to no tax solution.**

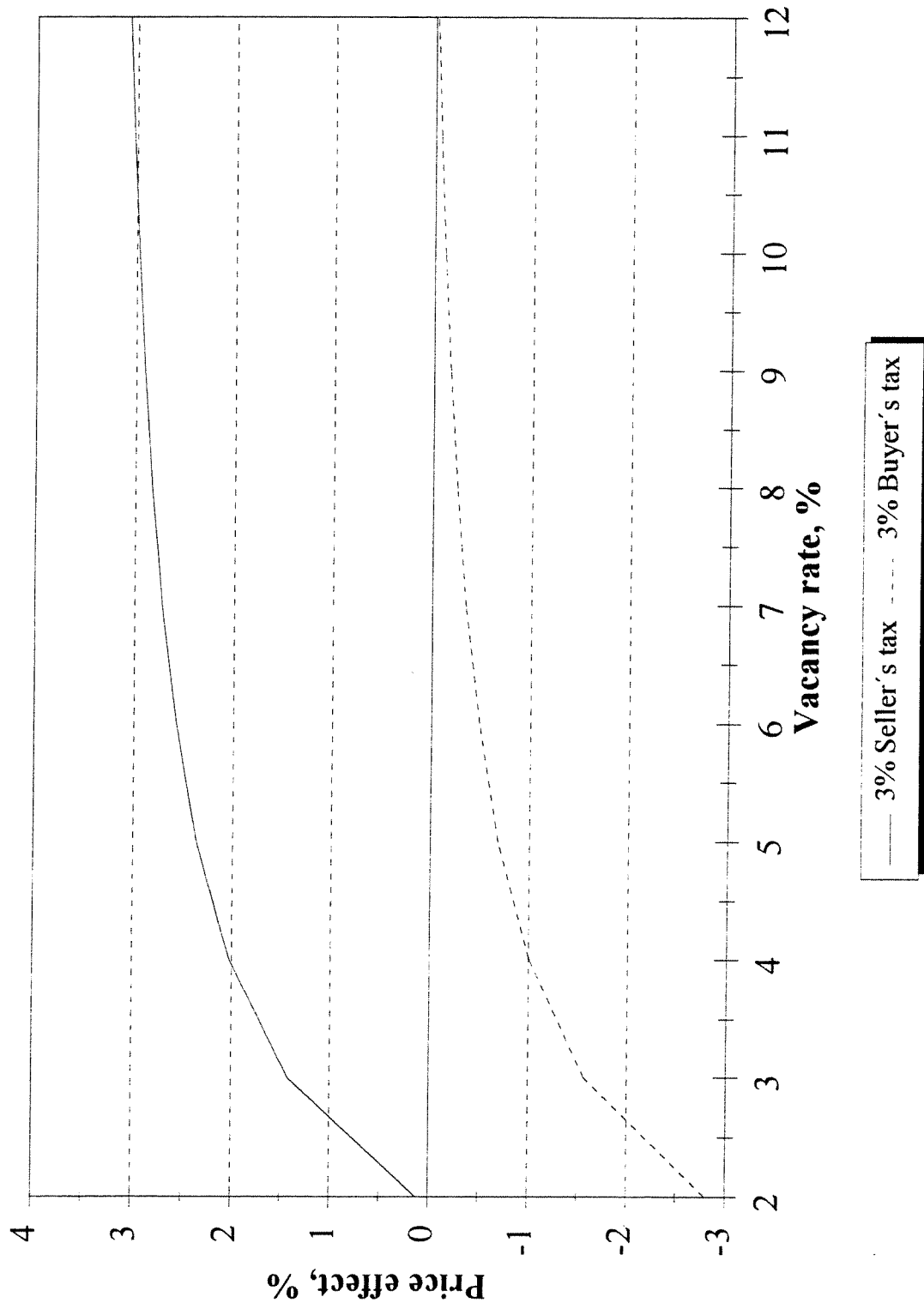


Fig 3. Effects of taxes on tax revenues.

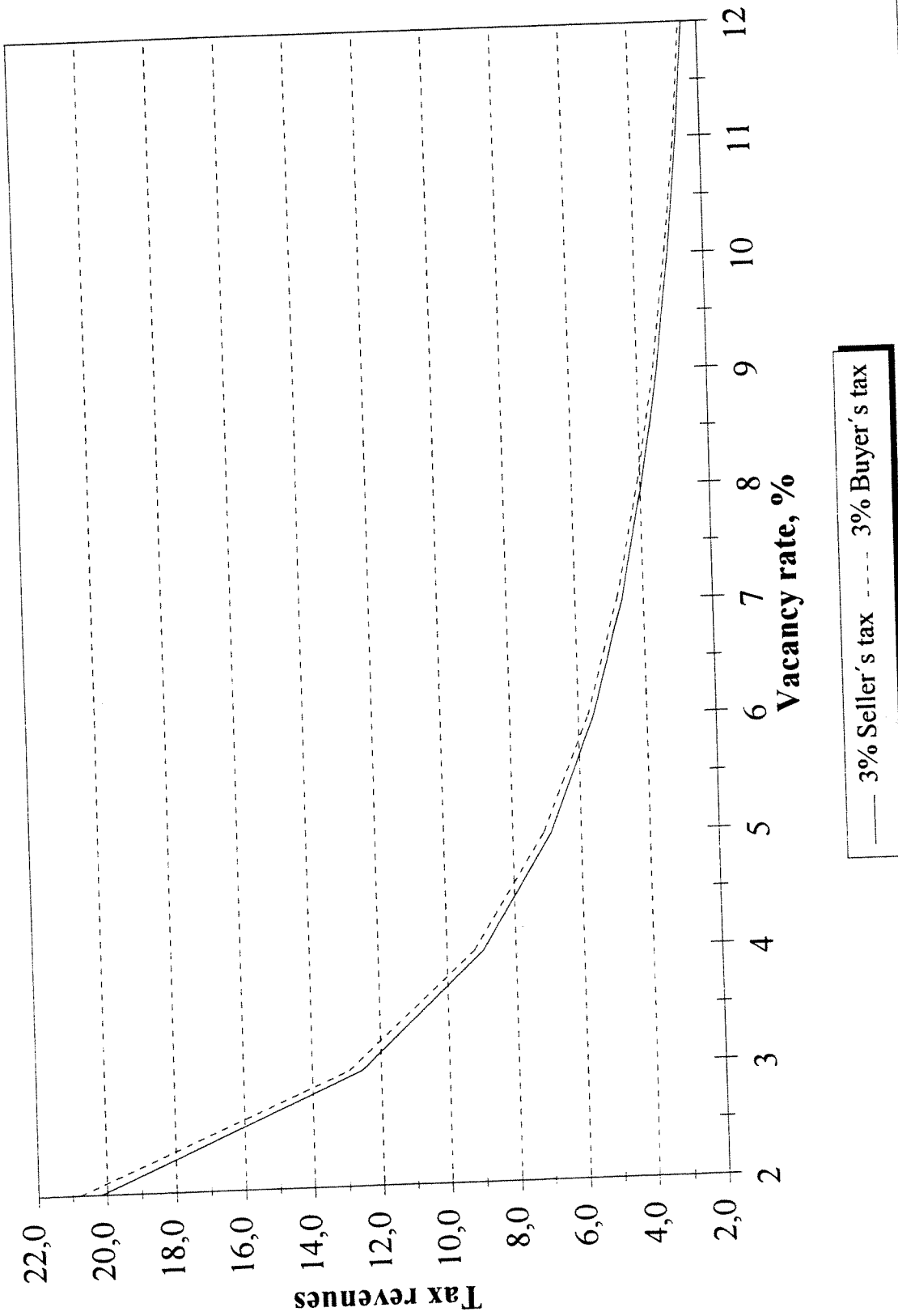


Fig 4. Effects of taxes on excess burdens.

