

Preliminary and incomplete. Comments welcome.

# Do Amortization Requirements Benefit Well-Off and Hurt Liquidity-Constrained Housing Buyers? \*

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## Abstract

Mortgage amortization requirements further constrain liquidity-constrained new housing buyers and reduce their demand for housing. The reduced total demand for housing lowers housing prices. For sufficiently liquidity-constrained new buyers, the loss from the restricted demand dominates the gain from lower prices, and their welfare falls. Well-off new housing buyers without liquidity constraints gain from lower prices, and their welfare rises. For “old” housing buyers, meaning those that already own housing and are selling it to buy new housing, there is no average gain from lower prices. For liquidity-constrained old buyers, there is a loss from the restricted demand, and their welfare falls.

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## 1 Introduction

Somewhat simplified, the main problem with the Swedish housing market is a combination of increasing demand and insufficient supply. Demand is increasing because of urbanization, migration, rising incomes, the lack of a functioning rental market, lower mortgage rates, and other factors. The lack of a functioning rental market means that any new entrants in the housing market need to buy rather than rent, so new demand for housing is therefore directed towards the market for owned rather than rented housing.

Supply growth is insufficient because of various structural barriers to supply increases and construction. Increasing demand and insufficient supply in the housing market lead to increasing

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\*Email: Leosven@gmail.com. I have benefitted from helpful previous discussions with Peter Englund, Harry Flam, Martin Flodén, and Hans Lind. Special thanks are due to Martin Flodén, who discovered an error in a previous version. The views expressed and any remaining errors are my own.

housing prices and increasing household debt. In order to buy, most new buyers need to borrow. Thus, given these structural conditions, increasing housing prices and household debt is a natural and obvious equilibrium consequence in a market with free price setting. There is no evidence that housing prices and household debt is rising faster than justified by demand and supply. It seems rather obvious that the solution to this problem is hardly to restrict demand.

Nevertheless, restricting demand is what the Swedish FSA, Finansinspektionen, is trying to do, by previously having introduced some amortization requirements and now having recently proposed stricter amortization requirements that have just been accepted by the Swedish government.<sup>1</sup>

The FSA restricts demand by imposing amortization requirements that are binding for liquidity-constrained housing buyers and force them to reduce their demand below what they can afford and would prefer. For well-off housing buyers that are not liquidity constrained, the amortization requirements are effectively nonbinding and do not reduce their housing demand. This is because amortization requirements are a particular kind of forced saving, namely in the form of a forced reduction of debt over time. Well-off housing buyers that face amortization requirement can easily, at low cost, either redirect some of their existing saving to amortization of their debt or borrow more and use the excess borrowing for the amortization payments. More precisely, they can deposit the excess borrowing and then use the deposits for the amortization payments (Svensson, 2016). Thus the well-off buyers' demand for housing is not affected by the amortization requirements.

In contrast, liquidity-constrained buyers do not have any excess saving that they can redirect toward amortization. They also face credit constraints that prevent them from borrowing more and use the excess borrowing for the amortization payments. Instead, the amortization requirements increase their fixed housing expenditures, make them more liquidity-constrained, and force them to reduce their housing demand.

The reduction in housing demand of the liquidity-constrained buyers reduces total housing demand and thereby housing prices. Well-off new housing buyers unambiguously gain from the fall in housing prices. The liquidity-constrained new buyers lose from the increased constraint provided

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<sup>1</sup> In June 2017, Finansinspektionen (the Swedish FSA) proposed new stricter amortization requirements as a way of moderating the increase in housing prices and household debt. It argued that, although housing prices and household debt posed only small risks to financial stability, the interest-sensitivity and the income sensitivity of consumption of highly indebted households would increase the risk of a recession (Finansinspektionen, 2017a). However, as shown in Englund and Svensson (2017) and Svensson (2017a,b,c), none of the FSA's arguments are valid. The increased interest-sensitivity of consumption makes monetary policy more effective and make it easier for the Riksbank to stabilize consumption and prevent a recession (Svensson, 2017a). There is no indication that the income-elasticity of consumption is increasing in the debt-to-income ratio (Baker, 2017; Svensson, 2017b). The government accepted the FSA's proposal in November 2017, repeating the FSA's arguments but without providing any independent analysis (Bolund, 2017). The stricter amortization requirements are estimated by the FSA to affect more than 30 percent of new borrowers in Stockholm and 15 percent in the country as a whole Finansinspektionen (2017b, p. 28).

by the amortization requirements and the necessity to reduce their housing demand. They gain somewhat from the fall in housing prices. If they are initially significantly liquidity-constrained, the loss is larger than the gain, and their welfare falls.

“Old” housing buyers here means buyers who already own housing and are selling it to buy new housing. Whereas new buyers, everything else equal, gain from lower housing prices, old buyers do not on average gain or lose from lower housing prices. Those who buy more housing gain, but those who buy less housing lose. Any gain or loss is small compared to that of new buyers. However, liquidity-constrained old housing buyers still lose from the tighter constraint provided by the new amortization requirements on the new mortgage associated with the new housing. Furthermore, because of the tighter constraint, the new housing is more likely to be less than the old housing, in which case they are more likely to also lose from the fall in housing prices.

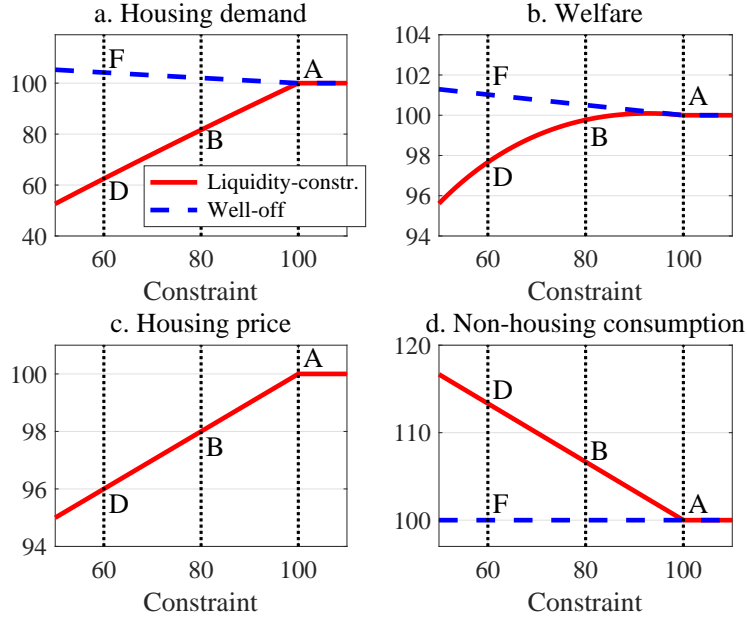
## 2 The effect of amortization requirements

The effects of amortization requirements are illustrated with the help of a simple model laid out in appendix A. The model has two types of new housing buyers, where “new” means that the buyers do not own any initial housing. The two types are called well-off and liquidity-constrained buyers, respectively. Well-off buyers are only constrained by their budget constraint and can thus buy the housing they can afford and prefer. Liquidity-constrained buyers are constrained not only by their budget constraint but also by a binding constraint on the value of the housing they can buy. They are thus initially constrained to buy less housing than they can afford and prefer.

Figur 2.1 summarizes the effects of the amortization requirements. Panel a shows the housing demand (measured along the vertical axis) of well-off and liquidity-constrained housing buyers as a function of the constraint on liquidity-constrained buyers (measured along the horizontal axis). The constraint is indexed such that the value 100 on the horizontal axis represents the minimum non-binding constraint, corresponding to the right-most vertical dotted line and point A. That is, for values less than 100, the constraint is binding. The middle vertical dotted line, at the value 80, corresponds to an initial constraint that has reduced the value of liquidity-constrained buyers’ purchases by 20%. This is like a liquidity-constrained new buyer being restricted to buying housing for SEK 4 million when the buyer can afford and would prefer housing for SEK 5 million.

The solid red line shows the housing demand of liquidity-constrained buyers. It is measured in physical units, such as square meters, but indexed such that the unconstrained level of housing

Figure 2.1: Effects of amortization requirements on the housing demand, the housing price, the welfare, and the non-housing consumption of well-off and liquidity constrained housing buyers.



demand, for constraints at 100 or above and thus to the right of the right-most vertical dotted line, is set to 100. For constraints less than 100, the housing demand of liquidity-constrained buyers is reduced. Points B and D show the housing demand at restrictions 80 and 60, respectively.

The reduced housing demand of the liquidity-constrained buyers reduces the total demand for housing and leads to a fall in the housing price. Panel c of figure 2.1 shows the housing price as a function of the constraint. The housing price is also indexed, and the unconstrained level is set to 100, corresponding to point A. We see that the initial constraint at the value 80, reducing the value of the housing demand of liquidity-constrained by 20%, has reduced the housing price from 100 to 98 at point B, that is, by 2%. This means that in equilibrium the housing quantity needs to fall by a bit less than 20%, more precisely from 100 to 81.6, in order for the value of housing purchases to fall by 20%; this is barely visible at point B in panel a.

The fall in housing prices allow well-off buyers to increase their housing demand. This is shown as the dashed blue line in panel a, which is also indexed to 100 at the unconstrained level.

The effect of the amortization requirements on the welfare of well-off and liquidity-constrained buyers is shown in panel b. Again, the welfare is indexed to 100 when the constraint is not binding, corresponding to point A. The dashed blue line shows the welfare of the well-off buyers. Their welfare unambiguously increases from the amortization requirements and the resulting fall in housing prices.

For the liquidity-constrained buyers, the situation is a bit more complicated. The solid red line in panel b shows their welfare as a function of the constraint. The liquidity-constrained buyers lose from a fall in housing consumption because of a tighter constraint, but they gain somewhat from the fall in the housing prices. For the initial constraint corresponding to 80, the loss dominates over the gain, and welfare is below 100 at point B. For a tighter constraint, resulting from the amortization requirements, welfare falls.

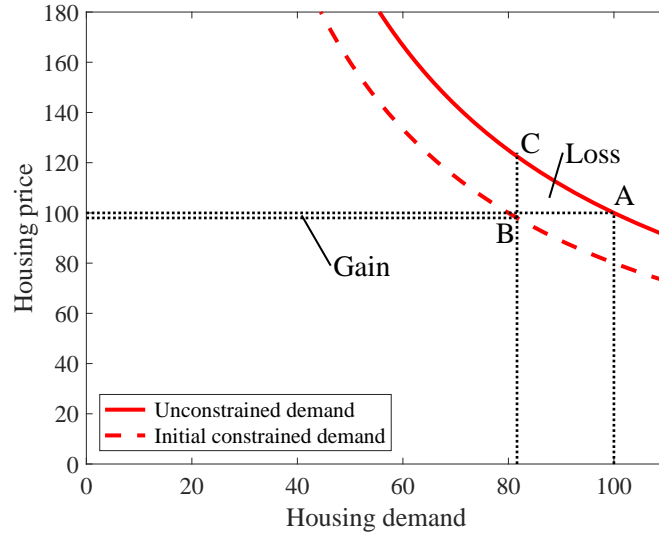
For an initial constraint that is barely binding, the gain from a fall in the housing prices is actually somewhat larger than the loss from the fall in housing consumption, and welfare actually increases a bit. This is barely visible in the panel.

The reason why the welfare of liquidity-constrained buyers initially rises and then falls when the constraint becomes increasingly binding is that, for a barely binding constraint, the gain is approximately linear in the constraint but the loss is approximately quadratic (as is explained in section 3). For an initial constraints that is barely binding, the linear dominates over the quadratic. For a more binding constraint, the quadratic dominates over the linear. We see in panel a that welfare falls at an increasing rate for liquidity-constrained but increases at an approximately constant rate for the well-off. For them, there is no quadratic loss, only a linear gain.

Panel d of figure 2.1 shows the non-housing consumption of well-off and liquidity constrained buyers, also indexed to 100 when the constraint is nonbinding, point A. For the well-off buyers, the non-housing consumption is unaffected by the amortization constraints and equal to their preferred level. In this simple model, for the liquidity-constrained, the reduction in the value of their housing purchases caused by the constraint results one-to-one in increased non-housing consumption. This increase in non-housing consumption contributes to the welfare and reduces the welfare loss from the constraint.

A more detailed and realistic model would take into account that the reduced value of housing purchases goes into forced saving rather than excess non-housing consumption. For liquidity-constrained buyers, this forced saving contributes less to welfare than non-housing consumption. This means that the simple model understates the welfare loss from amortization requirements. A small ad-hoc adjustment in the simple model of the welfare from the excess non-housing consumption can easily make the welfare loss from the constraint dominate from the gain from the housing-price fall and make welfare fall monotonically also for a barely binding constraint.

Figure 3.1: The change (Loss – Gain) in the liquidity-constrained new buyers’ consumer surplus from the initial constraint.



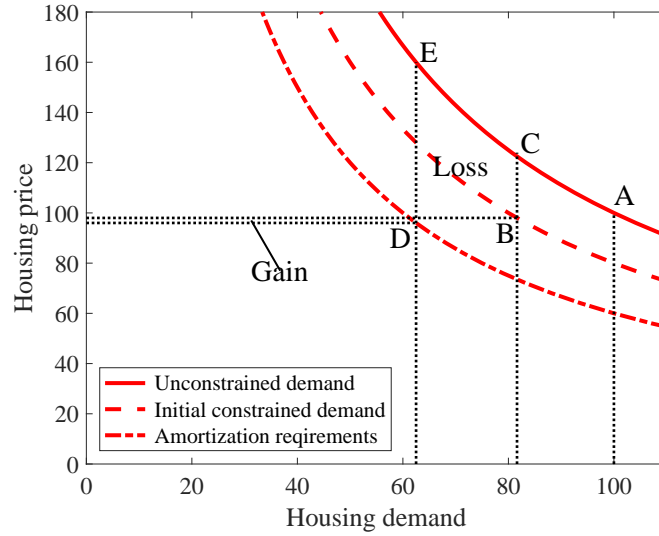
### 3 The change in consumer surplus

The standard approximation to welfare changes is the change in the consumer surplus (see appendix B). Figure 3.1 shows the change in the consumer surplus of the liquidity-constrained buyers from imposing the initial constraint, that is, the change from an unconstrained to the initial constrained equilibrium. The solid red line shows the unconstrained demand curve for housing of the liquidity-constrained buyers. Point A corresponds to the housing price and quantity, both indexed to 100, in the unconstrained equilibrium in the housing market. It corresponds to points A in figure 2.1.

The dashed red line shows the housing demand curve of the liquidity-constrained buyers when they face the initial constraint of 80, meaning that the value of their housing purchases is reduced to 80% of the value of the housing they can afford and prefer. The corresponding equilibrium is at point B, with a price equal to 98 and housing quantity equal to 81.6. This corresponds to the housing price at constraint 80 and point B in panel c of figure 2.1 and the housing quantity purchased by the liquidity-constrained buyers at this constraint at point B in panel a.

The consumer surplus for a given quantity of housing is the difference between the total amount the buyers are willing to pay for the housing and the amount they actually pay. At the unconstrained equilibrium at point A, at price 100 and quantity 100, the consumer surplus is given by the area of the shape bounded by the vertical axis, the unconstrained demand curve, and the horizontal dotted line extending to the left from point A. The total amount the buyers are willing to pay is the area

Figure 3.2: The change (Loss – Gain) in the liquidity-constrained new buyers’ consumer surplus from the amortization requirements.



below the demand curve between quantity 0 and 100, that is, the area of the shape bounded by the vertical axis, the demand curve, the vertical dotted line extending down from point A, and the horizontal axis. The amount they actually pay is 100 times 100, the area of the rectangle with its lower left corner at the origin and its upper right corner at point A. The difference between the areas is the consumer surplus.

By the same reasoning, at the constrained equilibrium B, with price 98 and quantity 81.6, the consumer surplus is given by the area of the shape bounded by the vertical axis, the unconstrained demand curve, the vertical dotted line BC, and the horizontal dotted line extending to the left from point B. Compared to the consumer surplus for the unconstrained equilibrium at A, the constrained equilibrium at B then involves a consumer-surplus loss of the area ABC and a gain equal to the area of the rectangle bounded above and below by the two horizontal dotted lines and left and right by the vertical axis and the the vertical dotted line from B. In this case, the loss exceeds the gain, and corresponds to the fall in welfare for the liquidity-constrained buyers in panel b in figure 2.1. The loss is approximately quadratic in the constraint (measured as the reduction from 100, that is, as the distance between the two dotted vertical lines). This is because it is approximately the area of a triangle, with base and height proportional to the constraint. The gain, the area of the rectangle mentioned above, is approximately linear in the constraint for a small reduction below 100. Thus, for a sufficiently small reduction, the gain will dominate the loss. Even though the

gain is very small, the loss will be even smaller.<sup>2</sup>

Figure 3.2 shows the additional change in the consumer surplus from imposing amortization requirements, that is the change from the initial constrained equilibrium to the more constrained equilibrium with amortization requirements. Point D shows the new equilibrium when amortization requirements are imposed, represented by a more binding constraint of 60. It has a price of 96, given by point D in panel c in figure 2.1 for the constraint of 60, and a quantity of 62.5, given by the solid red line in panel a at point D for the constraint of 60.

The consumer-surplus loss from the amortization requirements is given by the area of the shape DECB. The gain is given the area of the rectangle bounded above and below by the two horizontal dotted lines and left and right by the vertical axis and the vertical dotted line through point D. The loss exceeds the gain, which corresponds to the fall in welfare of the liquidity-constrained buyers in panel c of figure 2.1 from point B to point D from the change in the constraint from 80 to 60.

These calculations are made under the assumption that the housing supply is assumed to be fixed (as described in appendix A). This assumption exaggerates the fall in housing prices and the associated gain for new buyers compared to an assumption of an elastic supply of housing.

## 4 Indifference curves

The result can also be illustrated with the help of standard indifference curves. In figure 4.1, the downward sloping line from point Y and extending through point A shows the budget constraint of liquidity-constrained buyers in case they would not be constrained, corresponding to points A in figures 2.1, 3.1, and 3.2. The slope of the line is is the initial housing price before any binding constraints. Point Y shows the (indexed) income of the liquidity-constrained buyers. For a lower housing price, the budget line tilts around point Y, becomes flatter, and allows, everything else equal, the purchase of more housing or non-housing consumption.

Point A shows the housing and non-housing consumption that the liquidity-constrained buyers

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<sup>2</sup> A previous note erroneously used the constrained demand curve, the dashed red line, to compute the consumer surplus in the constrained equilibrium. I am grateful to Martin Flodén for quickly noting the error. Using the constrained demand curve disregards that the reduction in the value of housing purchases can be used for non-housing consumption. However, using the unconstrained demand curve involves the assumption that *all* of the reduction in housing purchases can be used for non-housing consumption (which is the case in the simple model laid out in the appendix).

In reality, amortization requirements imply that the reduction in housing purchases is used, partly or wholly, for forced saving, which for a liquidity-constrained buyer has less utility than non-housing consumption. Taking this into account in the consumer-surplus analysis would presumably involve using an adjusted somewhat lower demand curve than the unconstrained one, but not as low as the constrained one. Absent such an adjustment, the consumer-surplus analysis here underestimates the welfare loss from amortization requirements. Dealing appropriately with these issues clearly requires a more elaborate model than the simple one used here.



Figure 4.1: The unconstrained equilibrium, point A.

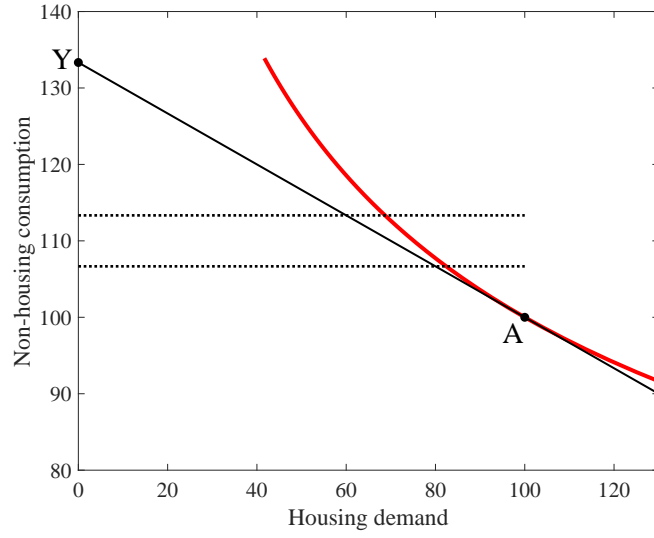


Figure 4.2: The initial constrained equilibrium, point B, and the constrained equilibrium with amortization requirements, point C.

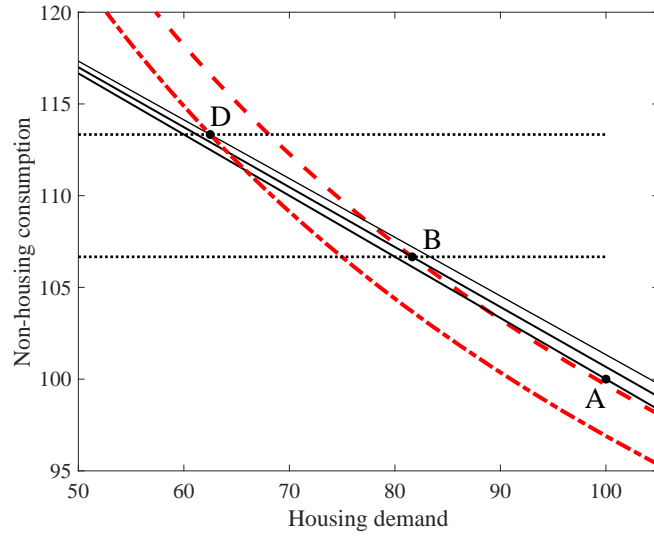
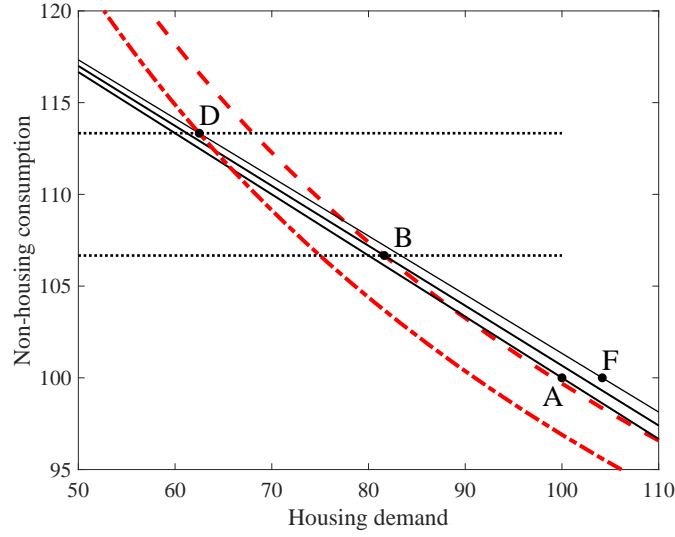


Figure 4.3: The unconstrained equilibrium at lower housing prices, point D.



would prefer it they were not constrained. The solid convex red curve shows the indifference curve corresponding to the maximum utility. As at points A in panels a and d in figure ??, the preferred housing and non-housing consumption is indexed to 100. The lower and higher horizontal dotted line show the constraints corresponding to, respectively, 80 and 60 in figure (2.1).

Figure 4.2 also shows the equilibrium at point B, where the liquidity-constrained buyers are constrained to reduced the value of their housing purchased by 80%, corresponding to point B in figures 2.1, 3.1, and 3.2. The reduction in housing demand from the the liquidity-constrained buyers leads to a fall in housing prices, which tilts the budget line through point Y to the right and leads to the equilibrium at point B, corresponding to point B. The dashed convex red curve through point B shows the corresponding indifference curve and utility level in this equilibrium, point B in panel a, figure 2.1. The indifference curve falls somewhat below point B, showing that the utility level at point B is somewhat below that at point A, corresponds to the utility level for the liquidity-constrained in panel a, figure 2.1, being a bit lower at point B than at point A.

Point D shows the equilibrium when amortization requirements are introduced, represented by a tighter constraint of 60 percent of the value of the preferred housing, corresponding to points D in figures 2.1, 3.1, and 3.2. The further reduced demand by liquidity-constrained buyers reduces the demand further, the housing price falls further, and the budget line tilts a bit further to right. The convex dashed-dotted red curve shows the indifference curve and utility level at point D. The indifference curve falls below point B, showing that the utility level is further reduced, corresponding to the utility level for liquidity-constrained buyers at point D in panel a, figure 2.1.

In figure 4.3, point F shows the unconstrained demand for housing at the lower housing price associated with the constrained equilibrium at point D. It shows the housing and non-housing demand a well-off buyer with the same preferences as a liquidity-constrained buyer (indexed to 100 for the unconstrained equilibrium at point A) and corresponds to points F in figure (2.1). The fact the budget line through point D lies outside the budget line for the housing price corresponding to the constrained equilibrium at point B shows that the well-off buyers benefit and increase their utility from the price fall caused by the amortization requirements. This corresponds to the well-off buyers' utility being higher at point F at the constraint 60 than at the constraint 80 in panel a, figure 2.1.

## 5 Conclusions

Mortgage amortization requirements further constrain liquidity-constrained housing buyers and reduce their demand for housing. The reduced demand lowers housing prices. New housing buyers, meaning those that do not initially own any housing, gain from lower housing prices. For sufficiently liquidity-constrained new buyers, the welfare loss from the restricted demand dominates over the welfare gain from lower housing prices, and their welfare falls. For well-off, not liquidity-constrained new buyers, there is no welfare loss from a restricted demand, only a welfare gain from lower prices, so their welfare rises.

Old housing buyers, meaning those that initially own housing and are selling it to buy new housing, do not on average gain or lose from lower housing prices and any gain or loss is smaller than the gain for new buyers. For liquidity-constrained old buyers, there is thus no welfare gain from lower prices, only a welfare loss from the restricted demand, and their welfare falls. For well-off old buyers, there is on average no welfare gain or loss from lower prices and amortization requirements, and their welfare is essentially unaffected.

On balance, amortization requirements hurt liquidity-constrained new and old buyers and benefit well-off new buyers.

These conclusions follow from a very simple model, where the reduction in housing purchases by liquidity-constrained buyers is used wholly for non-housing consumption. In reality, amortization requirements imply that the reduction in housing purchases is used, partly or wholly, for forced saving, which for a liquidity-constrained buyer has less utility than current non-housing consumption. This means that the simple model underestimates the liquidity-constrained buyers welfare

loss from amortization requirements. Taking the utility of forced saving into account requires a more a more elaborate and dynamic model than the simple one used here, perhaps a variant of the model used in Svensson (2016).<sup>3</sup>

Furthermore, amortization requirements are normally imposed on nominal debt rather than real debt. This means that a positive inflation rate, all else equal, implies a higher rate of amortization of real debt than of nominal, and thus a more binding real constraint for liquidity-constrained housing buyers. Generally, inflation and real growth imply that nominal housing expenditures substantially exceed real housing costs, because a substantial fraction of housing expenditures is actually an automatic amortization in the form of a reduction of debt relative to income and housing values. Amortization requirements adds to this discrepancy between housing expenditures and housing costs and further increase the barriers to entry in the housing market, especially for liquidity- and credit-constrained households when a functioning rental market is missing. The welfare losses from these barriers are likely to dominate the welfare losses discussed in this paper. Their assessment require further research and more elaborate and dynamic models of the housing and mortgage market.

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<sup>3</sup> In an intertemporal model, a binding amortization constraint means that the household has to reduce its current non-housing consumption below what it would prefer and instead increase its future non-housing consumption above what it would prefer. The the marginal utility of saving is lower than the marginal utility of current non-housing consumption.

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## Appendix

### A A simple model

Let there be two types of new housing buyers, indexed by  $i = 1$  and  $2$ , where type 1 are liquidity-constrained buyers and type 2 are well-off buyers. Assume that the buyers within each type are identical and have linearly homogenous utility functions. Then each type of buyer can be represented by a single representative buyer. Let  $Y_i$ ,  $H_i$ , and  $C_i$  denote, respectively, the income, the housing purchases (and thereby the housing consumption), and the non-housing consumption of a representative buyer of each type  $i = 1$  and  $2$ .

In a static model like this,  $Y_i$ ,  $H_i$ , and  $C_i$  may interpreted as constant (that is, permanent) income, housing consumption, and non-housing consumption, for which case  $p$  may be interpreted

as the constant price of housing services (the rent equivalent), which is assumed to be proportional to the housing price (which is true under the assumption of a constant interest rate and maintenance and operation cost being equivalent to a given rate of depreciation of the housing stock, see [Svensson \(2016\)](#)).

The amortization requirements for liquidity-constrained buyers will be represented by an implicit borrowing constraint and thus reducing the value of the housing purchase as well as the associated constant cost of housing services. One may see this as reflecting that liquidity-constrained borrowers need to use some of the loan for amortization payments, as in [Svensson \(2016\)](#).

Let

$$U_i(H_i, C_i) = \begin{cases} [\alpha_i^{1/\sigma} H_i^{1-1/\sigma} + (1 - \alpha_i)^{1/\sigma} C_i^{1-1/\sigma}]^{\frac{\sigma}{1-\sigma}} & \text{if } \sigma \neq 1, \\ \alpha_i^{-\alpha_i} (1 - \alpha_i)^{-(1-\alpha_i)} H_i^{\alpha_i} C_i^{1-\alpha_i} & \text{if } \sigma = 1, \end{cases} \quad (\text{A.1})$$

denote the utility function of buyer  $i = 1$  and  $2$ . Here  $\alpha_i$  ( $0 < \alpha_i < 1$ ) indicates the weight of housing in the expenditure of buyer  $i$  and  $\sigma > 0$  is the constant elasticity of substitution between housing and non-housing consumption. For  $\sigma = 1$ , the utility function is a Cobb-Douglas utility function with the expenditure shares  $\alpha_i$  and  $1 - \alpha_i$  for, respectively, housing and non-housing consumption.

The budget constraint of buyer  $i = 1, 2$  is

$$C_i = Y_i - pH_i, \quad (\text{A.2})$$

where  $p$  is the price of housing relative to non-housing consumption.

Well-off housing buyers are not affected by the amortization requirements. Either they are saving enough initially so they can at low cost redirect their saving to amortization, or they do not face any credit restrictions and can borrow more than necessary for the housing purchase, deposit the excess borrowing, and at low cost finance the amortizations from the deposits ([Svensson, 2016](#)). For simplicity, the cost of this is assumed to be zero. From [\(A.1\)](#) and [\(A.2\)](#) then follows that the housing demand of the well-off buyers is given by

$$H_2(p, Y_2) = \frac{\alpha_2 p^{-\sigma}}{\alpha_2 p^{1-\sigma} + 1 - \alpha_2} Y_2. \quad (\text{A.3})$$

For liquidity-constrained buyers, amortization requirements result in a restriction on the value of housing they can purchase, represented by the constraint

$$pH_1 \leq b_1 Y_1, \quad (\text{A.4})$$

where a smaller value of the parameter  $b_1$  ( $0 < b_1 \leq 1$ ) indicates a more binding amortization

requirement. From (A.1), (A.2), and (A.4) then follows that the housing demand of the liquidity-constrained buyers is given by

$$H_1(p, Y_1, b_1) = \min \left( \frac{\alpha_1 p^{-\sigma}}{\alpha_1 p^{1-\sigma} + 1 - \alpha_1}, \frac{b_1}{p} \right) Y_1. \quad (\text{A.5})$$

Equilibrium in housing market is the represented by

$$H_1(p, Y_1, b_1) + H_2(p, Y_2) = H, \quad (\text{A.6})$$

where  $H$  is the total supply of housing and is assumed to be fixed. Equations (A.3), (A.5), and (A.6) then determine the equilibrium price,  $p$ , as a function of the amortization requirements represented by  $b_1$ , as well as of the incomes  $Y_1$ ,  $Y_2$ , the total supply of housing  $H$ , and the parameters  $\alpha_1$ ,  $\alpha_2$ , and  $\sigma$ .

Given the equilibrium price, the housing purchases of liquidity-constrained and well-off housing buyers,  $H_1$  and  $H_2$ , are determined by (A.5) and (A.3), their non-housing consumption,  $C_1$  and  $C_2$ , are determined by (A.2), and their utility levels are determined by (A.1), all as a function of constraint  $b_1$  and the incomes  $Y_1$  and  $Y_2$ .

The benchmark parameters used are  $\alpha_1 = \alpha_2 = 0.25$  (approximately the weight of housing in the Swedish CPI),  $\sigma = 1$  (corresponding to a Cobb-Douglas utility function),  $Y_1 = 10$ ,  $Y_2 = 90$ , and  $H = 100$ . It is clear from equations (A.3), (A.5), and (A.6) that the relative size of  $Y_1$  and  $Y_2$  matters for the effect of the amortization requirements on the equilibrium housing price; everything else equal, the smaller the share of the liquidity-constrained buyers' income is, the smaller is the effect on the price. The benchmark share of income of liquidity-constrained new buyers is assumed to be 10% in total income of new buyers. The FSA estimates that the new amortization requirements will affect 15% of new borrowers in Sweden. If a half of them are liquidity-constrained, they are 7.5% of the new borrowers. If the (permanent) income of the liquidity-constrained is a half of the average of new borrowers, their income is only 3.75% of the total income of new borrowers. Furthermore, the new *borrowers* are a subset of the new *buyers*; some well-off new buyers do not need to borrow. Thus, a very rough calculation like this results in a number smaller than the assumed 10%.

The assumption of a fixed housing supply exaggerates the fall in housing prices from the amortization requirements compared to a situation with an elastic supply of housing. Given that the simple static model represents a more long-run situation of permanent income, housing consumption, and non-housing consumption, an assumption of an elastic supply is arguably more realistic.

## B Consumer surplus

The consumer surplus, the total willingness to pay less the actual amount paid, is an approximation to welfare that is exact if the marginal utility of “other” consumption (in this case, non-housing consumption) is constant. To see this, assume that the utility function is

$$U(H, C) = f(H) + C, \tag{B.1}$$

for which the marginal utility of non-housing consumption is constant (and for simplicity equal to 1). Recall the budget constraint,

$$C = -pH + Y. \tag{B.2}$$

The first-order condition for a maximum of (B.1) subject to (B.2) is

$$f'(H) = p. \tag{B.3}$$

It follows that  $p(H) \equiv f'(H)$  can be seen as the demand price (the marginal willingness to pay) as a function of  $H$ .

Furthermore, we can combine (B.1) and (B.2) and write, for any given  $H$  and  $p$ ,

$$F(H, p) \equiv U(H, -pH + Y) = [f(H) - pH] + Y \equiv \text{CS}(H, p) + Y,$$

where

$$\text{CS}(H, p) \equiv f(H) - pH \tag{B.4}$$

is the consumer surplus. We can write (B.4) as

$$\text{CS}(H, p) = \int_{h=0}^H p(h)dh - pH. \tag{B.5}$$

The first term on the right-hand side is the integral under the demand curve from 0 to  $H$ , that is, the total willingness to pay. The second term is minus the actual amount paid, which correspond to the utility of the non-housing consumption. Thus, the consumer-surplus analysis takes into account that a restriction that reduces  $H$  at given  $p$  not only reduces the utility from  $H$  but also reduces the amount paid for  $H$  and thereby increases the non-housing consumption and the utility from the latter.

Because the utility function used here is a CES/Cobb-Douglas utility function, (A.1), for which the marginal utility of non-housing consumption is not constant, the consumer surplus is in this case an approximation to welfare. Thus, the welfare effects in figures 3.1 and 3.2 are approximations to the welfare effects in figure 2.1.