B Online Appendix: Matching Multiplier in a calibrated model

This section explores the matching multiplier mechanism in a dynamic setting. This is particularly important as I estimate MPCs using unemployment as the identifying income shock. Unemployment is a persistent shock, and therefore, the MPCs that I estimate include both the response of consumption today to income today, but also the response of consumption today to expected income shocks in all future periods. The empirical matching multiplier accounts for these dynamics only insofar as they are embedded in the empirical MPC estimate, but does not formally capture the role of these dynamics in the multiplier. Therefore, the empirical matching multiplier is a reduced-form approximation to a more complicated dynamic process.[57]

I explore this mechanism within a standard Bewley-Huggett-Aiyagari model augmented along three dimensions. First, I introduce endogenous labor supply and rich consumer heterogeneity. Second, I pair this model of aggregate demand with fixed wages in the short run, which capture the role that this mechanism plays in demand-driven amplifications. Third, I introduce an exogenous labor rationing process that generates labor income fluctuations in the presence of fixed wages. Within the context of this model, I clarify the role that the persistence of the unemployment shock plays in shaping my estimates for the importance of the matching multiplier mechanism. I show that the persistence of the unemployment shock is important in determining the level of the multiplier and matching multiplier, but is not the driving force for the amplification coming from the covariance. Additionally, I show that the empirical approximation from Section 2 closely captures the dynamic estimates under the assumption that the aggregate shock has the persistence of the average unemployment spell.

B.1 Environment

The following setting is similar to the generalized setting in Auclert et al. (2018) and is a simplified version of the multisector model in Flynn et al. (2021). Since the focus of this exercise is to understand the role of heterogeneity in the demand side, I allow for rich heterogeneity among consumers and keep the supply side intentionally simple. Consider an economy in discrete time with T periods. The economy is populated by a continuum of agents of I types, where each type i has a mass ν_i of individuals such that $\sum_i \nu_i = 1$. Households within each group are ex ante homogenous, but households face idiosyncratic risk in their productivity or labor supply $e(s)$, a process that may vary across demographic groups I. Households across groups may differ both in the income process they face and in their discount rates (β_i). Households have preferences over both consumption and leisure, and agents have the ability to borrow and save into a real asset ($a_{i,t}$) to smooth consumption but are subject to a borrowing constraint that $a_{i,t} \geq b$. The household's problem therefore is to choose paths for their consumption $c_{i,t}$ and labor supply $l_{i,t}$ to maximize their utility taking wages, prices, and the real interest rate as given:

$$\max_{c_{i,t}, l_{i,t}} \sum_{t=0}^{T} \beta_i^t E[u(c_{i,t}) - v(l_{i,t})] \tag{B1}$$

subject to

$$w_t l_{i,t} e(s) + r_t a_{i,t-1} - \tau_{i,t} = p_t c_{i,t} + a_{i,t} \quad , \quad a_{i,t} \geq b \tag{B2}$$

where $\tau_{i,t}$ are lump sum taxes, b is the borrowing constraint, and p_t is the price of the final good at time t. I assume that $u(c) = \frac{c^{1-\omega^{-1}}}{1-\omega^{-1}}$ and $v(l) = \frac{l^{1+\psi^{-1}}}{1+\psi^{-1}}$, where ω is the intertemporal elasticity of substitution and

[57] Alternatively, the empirical matching multiplier could be interpreted as the multiplier in which period 1 is the short run and period 2 is the long run.

ψ is the Frisch labor supply elasticity.[58]

While the demand side of the model features rich heterogeneity, the supply side of the model is simple.[59] All workers are employed by a representative competitive firm, which produces with constant returns to scale technology and takes labor as the only input:

$$Y_t = L_t \ \forall \ t \tag{B3}$$

Firm profit maximization implies that

$$w_t = p_t \ \ \forall \ t \tag{B4}$$

The government sets potentially individual-specific lump sum taxes $\tau_{i,t}$ to finance government spending G_t. Rather than balance its budget strictly between periods, the government can issue bonds B_t to smooth fluctuations across periods and therefore is subject to an intertemporal budget constraint:

$$\sum_t \frac{\tau_{i,t}}{\prod_{i \le t}(1+r_i)} = \sum_t \frac{p_t G_t}{\prod_{i \le t}(1+r_i)} \tag{B5}$$

I assume that government spending preferences are given exogenously by θ_G, such that $G_t = G(r_t, \tau_t, \theta_G)$. Even though this fiscal rule is specified exogenously, government spending still responds to interest rate changes in order to maintain the budget constraint in Equation B5.

B.2 Equilibrium and the output multiplier

Consider first the case where all prices are fully flexible. The household problem in Equation B1 results in a demand for consumption and a labor supply function given by

$$c_{i,t} = c_i(\{\lambda_t\}_{t \in T}, \{\tau_{i,t}\}_{t \in T}, \beta_i, b) \tag{B6}$$

$$l_{i,t} = l_i(\{\lambda_t\}_{t \in T}, \{\tau_{i,t}\}_{t \in T}, \beta_i, b) \tag{B7}$$

where $\lambda_t = \{r_t, w_t, p_t\}$ is the vector of prices. These are Marshallian demands, and thus these functions only depend directly on exogenous parameters ($\beta_i, b, \tau_{i,t}$) and prices (λ_t). The goods and labor market clearing condition are given, respectively, by

$$Y_t = C_t + G_t = \sum_i \nu_i c_{i,t} + G_t \ \ \forall \, t \tag{B8}$$

$$L_t = \sum_i \nu_i l_{i,t} e(s) \ \ \forall \, t \tag{B9}$$

An allocation of $\{c_{i,t}\ ,\ l_{i,t},\ \tau_{i,t}\ ,\ r_t\ ,\ p_t\ ,\ w_t\ ,\ G_t\ ,\ Y_t\}$ that satisfies Equations B4, B5, B6, B7, B8, and B9 characterizes the flexible price equilibrium.

[58] These functional forms are used for the quantitative exercise in this section. However, the results in this section apply to a broader set of preferences. See Auclert (2019) or Flynn et al. (2021) for a discussion using more general preferences. These preferences have the advantage that they guarantee that the resulting labor supply and Marshallian demand functions are continuous and differentiable in r_t. The assumed CRRA utility function also exhibits sufficient diminishing marginal utility of consumption to guarantee the existence of an equilibrium. See Appendix **??** for a discussion of the assumptions required to guarantee the existence of equilibrium.

[59] In a similar framework, Auclert et al. (2018) explore the importance of worker MPCs in a model with an enriched supply side that includes capital, sticky prices, and a Taylor rule for monetary policy. They show that while these modifications reduce the overall size of the multiplier, worker MPCs still remain crucial in determining the output response to fiscal policy. Specifically, they show that in a model that matches the empirical estimates of intertemporal MPCs and with deficit-financed spending, impact multipliers can be above 1, even with active monetary policy, distortionary taxation, and investment crowd out.

The exercise in this paper will be to consider the response of an economy, initially at this flexible price equilibrium, to an unanticipated demand shock when wages are fixed for $k+1$ periods.[60] Equation B4 immediately implies that prices are also fixed over this period.With fixed wages, the interest rate does not adjust to clear the labor market, and thus, workers are off their labor supply curves for the first k periods (i.e., in response to a negative shock, there are workers who would like to work more but cannot because a firm is not willing to hire them). Rather, in those periods, labor supply is rationed, and a worker's labor supply is imposed exogenously as

$$l_{i,t} = n_{i,t}(Y_t) \tag{B10}$$

such that $\sum_i \nu_i n_{i,t} = L_t$.[61] This rationing function takes as inputs the aggregate change in output and the amount workers would like to work given the wage $l^*_{i,t}$, and returns a labor supply $n_{i,t}$ for each individual. This function is what determines the change in the worker's earnings in response to an aggregate demand shock. This reduced form specification, similar to Werning (2015), captures the notion that, for example, in response to a negative demand shock, workers are not able to work as much as they would like. In order to capture the relationship between the exposure of worker earnings to aggregate shocks and worker MPCs documented in Section 4.2, I parametrize the rationing function $N(Y_t) = \{n_{i,t}\}$ as

$$n_{it} = \frac{Y_t}{L^*_t}\left(1 - \chi\overline{MPC} + \chi MPC_i\right) l^*_{it} \tag{B11}$$

where $L^*_t = \sum_i \nu_i l^*_{i,t}$, $\overline{MPC}$ is the earnings-weighted average MPC in the economy and χ is the slope of this incidence function with respect to GDP. This formulation of the rationing function implies that the elasticity of worker i's earnings to the aggregate is linear in the worker's MPC and is given by $\gamma_i = 1 - \chi\overline{MPC} + \chi MPC_i$.

Since the interest rate is not pinned down by the labor market clearing condition, it must be set by monetary policy. Assume for simplicity that the central bank targets a fixed real interest rate, $r_t = \overline{r}$.[62] In this rationing equilibrium, consumer demand becomes

$$c_{i,t} = c_i(\{y_{i,t}\}_{t\leq k}, \{\lambda_t\}_{t\in T}, \{\tau_{i,t}\}_{t\in T}, \beta_i, b) \tag{B12}$$

This is similar to the flexible price condition (Equation B6), except that now it is a function of incomes in periods 1 through k, as these are now *exogenously* given by the rationing function.

Definition *The rationing equilibrium is defined as the set of* $\{c_{i,t}\ ,\ l_{i,t},\ \tau_{i,t}\ ,\ r_t\ ,\ p_t\ ,\ w_t\ ,\ G_t\ ,\ Y_t\}$ *such that firms optimize as in Equation B4, consumers optimize consumption according to Equation B12 and supply labor according to* $N(Y_t, l_{i,t-1})$ *for periods* 1 *through* k *and according to Equation B7 for* $t \geq k$, *and goods and labor markets clear in each period as in Equations B8 and B9.*

Using bold variables to represent vectors of aggregate variables (i.e. $\mathbf{Y} = \{Y_t\}$), I derive the response of the economy to shocks in Proposition 1. I define the partial equilibrium effect of the shock on output as the response of the economy to a shock to any of the parameters of the model, before accounting for any

[60] See Auclert (2019) for the case where wages are sticky indefinitely.

[61] A more complete alternative to this rationing function is to explicitly model heterogeneity in the labor market through search frictions. See Ravn and Sterk (2020) for a recent example. Additionally, while the resulting mechansim is similar, the endogenous redistribution mechansim here differs from that in Bilbiie (2008) and Bilbiie (2020). In his setting, cyclical inequality comes from the redistribution of firm profits – the government taxes firm profits (held by the unconstrained agents) and rebates them lump-sum to the constrained agents. I allow for a rationing function that is reduced form but disciplined by labor market data.

[62] Since my focus is on quantifying the importance of heterogeneity in the labor market, I abstract from potential offsetting effects coming from countervailing monetary policy.

of the general equilibrium responses of the economy.[63] In this economy, this amounts to all effects on the economy *before* incomes or interest rates change. Let $\partial \mathbf{Y}$ be the vector of the partial equilibrium change in output in each period. Define C_Y to be a matrix where the k, j entry is given by $\frac{dc_k}{dY_j} = \sum_i \frac{dc_{i,k}}{dy_{i,j}} \gamma_i \frac{l_{i,j}}{L_j}$, which is the aggregate response of consumption at time k to income in time j.

Proposition 1. *Under the assumption that wages are sticky for $k+1$ periods, for any shock to parameters $(\beta_i, \tau, \theta_G)$, the total change in output from an initial flexible price allocation is given to first order by:*

$$d\mathbf{Y} = \left(I - \mathbf{C_Y} J_k - (\mathbf{C_r} + \mathbf{G_r}) J_{T-k} (\mathbf{L_r})^{-1}\right)^{-1} \partial \mathbf{Y} \tag{B13}$$

where subscripts denote partial derivatives (i.e. $\mathbf{C_r}$ is the partial derivative of consumption with respect to r), and J_k and J_{T-k} are diagonal matrices with 1s in the first k or the last $T-k$ entries, respectively.

Proof. Begin by totally differentiating the good market clearing condition (Equation B8) in each period t:

$$dY^t = \sum_{j=1}^{k} C_{t,y_j} dy_j + \sum_{j=1}^{T} (C_{r_j} + G_{r_j}) dr_j + \sum_{j=1}^{T} C_{t,\tau} d\tau_t + C_{t,\beta} d\beta + \sum_{j=1}^{T} G_{t,\tau_t} d\tau_t + G_{t,\theta_G} d\theta_G \tag{B14}$$

where $C_{t,x}$ is an $(1 \times I)$ vector across individuals where each entry is the partial derivative of the individual consumption function $c_i(\{y_{i,t}\}_{t \le k}, \{\tau_{i,t}\}_{t \in T}, \{r_t\}_{t \in T}, \beta_i, b)$ with respect to the variable x. Similarly, derivatives dy_j, dr_j, $d\beta$, $d\tau$ and $d\theta_G$ are $(I \times 1)$ vectors that capture the change in the exogenous parameters for each individual i. Recall that in the rationed equilibrium, income is exogenous in all rationed periods, and thus enters the consumption function. Note that the first sum is only across periods 1 through k, the periods in which there is labor market rationing. Beyond that, the workers are back on their labor supply curves and their income is endogenously given by their decisions and prices. By the definition of the income process imposed by the rationing function in Equation B11,

$$dy_{i,t} = n_{i,t} - l_{i,t-1} = \gamma_i \frac{l_{i,t-1}}{L_t} dY_t$$

Denote N_y as the I vector where the i entry is $dy_{i,t} = \gamma_i \frac{l_{i,t-1}}{Y_t}$. Plugging this in, we get:

$$dY^t = \sum_{j=1}^{k} \left(C'_{t,y_j} N_y dY_j\right) + \sum_{j=1}^{T} (C_{r_j} + G_{r_j}) dr_j + \sum_{j=1}^{T} C_{t,\tau} d\tau_t + C_{t,\beta} d\beta + \sum_{j=1}^{T} G_{t,\tau_t} d\tau_t + G_{t,\theta_G} d\theta_G \tag{B15}$$

Note that $C'_{t,y_j} N_y = \frac{dc_t}{dy_j} = C_{t,j}$, which is the aggregate response in time t to a change in income at time j. Equation B15 holds for all periods t, and stacking equations, this becomes

$$dY = C_Y J_k dY + (C_r + G_r) dr + C_\tau d\tau + C_\beta d\beta + G_\tau d\tau + G_{\theta_G} d\theta_G \tag{B16}$$

where C_Y is a matrix where the m, n entry is the aggregate consumption response at time m to an income shock in time n and J_k is a diagonal matrix with 1s only for the first k periods. For the first k periods, the interest rate is pinned down by the monetary policy rule (rather than by labor market clearing). Given the rule specified,

$$dr_t = 0 \quad \forall t \le k$$

[63] See the proof of Proposition 1 in Appendix **??** for a more detailed delineation of partial and general equilibrium effects.

After k periods, the interest rate goes back to the flexible price scenario and the change in the interest rate is pinned down by the labor market clearing condition. The total derivative of the labor market clearing condition is given by:

$$dY_t = \sum_{j=0}^{T} L_{t,r_j} dr_j + \sum_{j=1}^{T} L_{t,\tau} d\tau_t + L_{t,\beta} d\beta \quad \forall t > k$$

Stacking across periods and solving for dr, we get the expression for the change in the interest rate at time $t > k$:

$$dr = (L_r)^{-1} (dY - L_\tau d\tau - L_\theta d\theta)$$

Stacking these equations over time and defining ∂Y as a $(1 \times T)$ vector that is the change in output in each period before incomes and interest rates have been allowed to adjust:

$$\partial Y = C_\tau d\tau + C_\beta d\beta + G_\tau d\tau + G_{\theta_G} d\theta_G + (C_r + G_r) J_{T-k} (L_r)^{-1} (L_\tau d\tau - L_\beta d\beta)$$

we can rewrite Equation B16 as

$$dY = C_Y J_k dY + (C_r + G_r) J_{T-k} (L_r)^{-1} dY + \partial Y \tag{B17}$$

where dY and ∂Y are $T \times 1$ matrices and C_Y is a $T \times T$. J_k is just a diagonal matrix with ones along the diagonal for the first k entries, and J_{T-k} is a diagonal matrix with 1s for the last $T-k$ entries. C_r, G_r are r_y are $T \times T$ matrices.

□

The first term (i.e. $C_y J_k$) captures the heterogeneous agent intertemporal version of the traditional Keynesian multiplier and embeds the mechanism that is the key focus of this paper. This matrix of intertemporal MPCs features prominently in Auclert et al. (2018), who argue in a similar setting that these moments are essential for determining general equilibrium effects in heterogeneous agent models. Due to the forward-looking nature of the consumer's problem, what matters for the total consumption response today is not just the change in today's income but also the change in future period incomes. The matrix J_k simply captures the fact that wages are only fixed for some period; thus, the consumer only responds directly to income changes in those periods. The heterogeneous incidence of labor shocks directly affects the magnitude of C_Y – when high-MPC workers have higher γ_i, the components of the C_Y matrix are larger.

The second term (i.e. $(\mathbf{C_r} + \mathbf{G_r}) J_{T-k} (\mathbf{L_r})^{-1}$) captures the movements in the interest rate in periods after k. In those periods, the interest rate will adjust to bring workers back onto their labor supply curves and clear the labor market. Workers anticipate the future adjustment, and thus, consumption today will depend on the future change in the interest rate. Proposition 1 shows that this matrix is a sufficient statistic for characterizing the first-order general equilibrium effect on output of a demand shock.

Using Proposition 1, I define the matching multiplier in Corollary 1 as a special case of the model that abstracts from the potentially offsetting price effects far in the future.

Corollary 1. *The Matching Multiplier is defined as the difference in the output response to any small unanticipated shock to parameters (β, τ, θ_G) between the actual case where γ_i varies across i and the case where $\gamma_i = 1$. Under the assumption that $C_r + G_r = 0$ and under the assumption that wages are sticky for $k+1$ periods, this is given by:*

$$MM = \left[(I - \mathbf{C_Y}(\gamma_i)) J_k)^{-1} - (I - \mathbf{C_Y}(\gamma_i = 1)) J_k)^{-1} \right] \tag{B18}$$

where subscripts denote partial derivatives (i.e. $\mathbf{C_Y}$ *is the partial derivative of consumption with respect to* y*) and* J_k *is a diagonal matrices with 1s in the first* k *entries.* $\mathbf{C_Y}(\gamma_i)$ *denotes the aggregate intertemporal MPC matrix when* γ_i *varies by individual and* $\mathbf{C_Y}(\gamma_i = 1)$ *reflects the case where* $\gamma_i = 1$ *for all individuals.*

A comparison of Corollary 1 with the empirical matching multiplier derived in Section 2 demonstrates that the empirical moment from Equation 4 is a reduced form approximation of the multiplier in this dynamic setting. Recall that the k, j entry is given by $\frac{dc_k}{dY_j} = \sum_i \frac{dc_{i,k}}{dy_{i,j}} \gamma_i \frac{l_{i,j}}{L_j}$, which is the aggregate response of consumption in period k to an income shock in period j. Were the MPC estimates ($\widehat{MPC_i}$) in Section 4.1 based on a purely transitory shock, then $\widehat{MPC_i} = \frac{dc_{i,1}}{dy_{i,1}}$ and the empirical matching multiplier from Section 2 would be exactly the sufficient statistic in Proposition 1 in the case that wages were only sticky for 1 period. However, as discussed above, the MPCs that I estimate capture the consumption response to unemployment, which is a more durable shock, and therefore $\widehat{MPC_i} \neq \frac{dc_{i,1}}{dy_{i,1}}$. In the dynamic setting, there is no direct analytical mapping between the empirical covariance and the matching multiplier defined in Corollary 1. Therefore, the exercise in the following sections will be to calibrate the dynamic model below using the average empirical MPC and the estimated covariance between MPCs and earnings elasticities as targeted moments and explore the matching multiplier in the dynamic setting.

B.3 Model calibration

In order to match the empirical exercise, where I consider heterogeneity in MPCs and earnings sensitivities across both demographic and income groups, I calibrate an economy with eight demographic groups characterized by the combination of two genders, two education bins, and two race bins. Within each demographic group, agents are ex ante homogenous, but across demographic groups, agents differ along several ex ante dimensions.

First, and most importantly, I allow each demographic group to have a different income process that captures differences in the overall riskiness of income, features earnings shocks that mirrors the unemployment shock that I use to estimate the MPC in Section 4.1, and allows for heterogeneity in the persistence of that unemployment shock. I adopt a 2-part income process, where total earnings are given by

$$Y_{it} = e_{it} * w_{it}$$

where e_{it} is scalar for the number of months employed and w_{it} are the monthly earnings among the employed. I assume that these two processes are independent and calibrate them separately for each group.

I model the unemployment process as a discrete-time Markov process with two states – employed for the whole year ($e_{it} = 1$) and unemployed for some fraction of the year ($e_{it} = X$, where X is the average fraction of earnings lost in the year of unemployment). The transition probabilities between these two states are determined by the job-finding (f) and job-separation (s) rates, which I calculate for each demographic group using the measured job flows in the monthly basic Currently Population Survey (CPS).[64] Panel A of Table B1 reports the estimates. Consistent with prior literature, I find that, on average, job finding rates are higher for the more educated and for men. Table B2 demonstrates that the unemployment rate and unemployment durations implied by these labor market flows closely capture the empirical heterogeneity in these variables across demographic groups. Under the assumption that one earns nothing in

[64] In calculating the labor market flow rates, I abstract for non-participation and define $f = \frac{UE}{UE+UU}$ and $s = \frac{EU}{EE+EU}$ where UE is the number of people transitioning from unemployment to employment across months, UE is the number from unemployment to employment, and so on. I restrict the sample to only include 1994-2018, those who report being either unemployed or employed, and those between the ages of 25 and 62. From that sample, I calculate the probability that across two consecutive months, someone transitions from unemployment to employment and from employment to unemployment. I then average these monthly rates across the entire sample period.

the periods of unemployment, the differences in the job-finding and job-separation rates fully characterize the heterogeneity in the persistence of unemployment across demographic groups.

I assume that the earnings of the employed (w_{it}) follow an AR(1) process with persistent and transitory shocks, the parameters of which are the persistence parameter, the variance of the persistent shock, the variance of the transitory shock, an initial variance in earnings, and an average earnings level. I estimate these parameters following the methodology in Heathcote et al. (2010) and using the earnings of those who report being employed in the Panel Study of Income Dynamics.[65] Panel B of Table B1 reports the level and variance of earnings produced by these estimates for each demographic group. I capture the well-documented differences in the average earnings by gender, race, and education.[66]

For each group, I set the intertemporal elasticity of substitution to be 1.5, assume that agents cannot borrow (i.e., $b = 0$), and set the interest rate to be 1.02. Taking the earnings process for each demographic group as given, I choose the discount rate such that I match the average "empirical MPC" for each demographic group. In other words, I choose the discount factor such that the earnings-weighted average consumption drop per dollar lost upon transitioning to the unemployment state equals the earnings-weighted average MPC that I estimate in the PSID using the unemployment shock. The magnitude of this "empirical MPC" will in part reflect the persistence of the unemployment shock – all else equal, when the unemployment shock is more persistent, the average MPC is higher. Column 6 of Table B1 shows the resulting annual discount rates, which vary from 0.85 to 0.98. Empirically, groups with higher MPCs (Column 6) and more volatile incomes (Column 5) have lower discount rates (Column 7). Since agents are risk-averse, agents facing more income volatility want to accumulate assets, which pushes them away from their borrowing constraint and brings down the average MPC of that group. However, since it is precisely those groups that have higher measured MPCs, a higher degree of impatience is needed to match the MPC of the group in the model. The discount rates in the model need not reflect pure differences in time preferences across individuals and may also capture unmodeled differences in access to the banking sector of costs of borrowing. Even so, the estimates of the discount factor are actually in line with empirical estimates, both on average and in their patterns across demographics. For example, using experimental evidence in Denmark, Harrison et al. (2002) estimate higher discount factors for the rich, skilled, and educated. The last column of Table B1 shows the MPC in the model out of an unanticipated and transitory income shock. Unsurprisingly, for all demographic groups, this MPC is lower than the empirical MPC, but the two are highly correlated ($\rho = 0.97$), demonstrating that heterogeneity in the persistence of the unemployment shock across groups is not a key driver of MPC heterogeneity in the model.

Lastly, having matched the average MPC with the discount factor, I match the covariance between MPCs and earnings elasticities with the parameter χ in the rationing function. I estimate this parameter such that the $Cov(\widehat{MPC}_i, \gamma_i)$ is equal to 0.09, which is the empirical estimate from Section 5. I get that $\chi = 1.95$, which is similar to the empirical estimate in Table 2 as well.

B.4 Model estimates

I begin exploring the model-based estimates of the matching multiplier mechanism by looking at the importance of the incidence of the shock on the response of aggregate consumption. The left panel of Figure B1 shows the aggregate MPC in two scenarios. In the "actual scenario," I consider an aggregate shock

[65] I restrict attention to those individuals who report being employed at the time of the PSID survey, are between the ages of 30 and 40, and for whom I can impute an MPC (i.e., observations with at least two lags of earnings).

[66] These parameter estimates are similar to, although slightly higher than, comparable estimates in the literature. For example, Heathcote et al. (2010) estimate an average permanent component of around 0.015 and a transitory component of around 0.1. Carroll et al. (2015) review the literature and show that estimates in the literature for the variance of the permanent component range from 0.01 to 0.054 and that estimates of the transitory variance range from 0.01 to 0.2.

to incomes that is distributed to workers such that the earnings elasticity of each worker is exactly equal to the γ_i, calibrated as described above. In the "benchmark scenario," I consider an aggregate shock to income of the same size that is distributed such that the earnings elasticity of all workers is equal to 1. I derive the aggregate MPC by aggregating the response of consumption and dividing by the size of the aggregate change in incomes in period 1.

Before reporting those estimates, the first column in the left panel of Figure B1 reports, for comparison, the increase in the aggregate MPC coming from the covariance that I estimated in Section 4. The benchmark scenario in this case is simply the earnings-weighted average MPC in the data. As in Section 2, the aggregate MPC in the actual scenario is the benchmark MPC plus the estimated covariance between the empirical MPC and the earnings elasticity, which is 0.09.[67] With this specification, the estimated covariance increases the aggregate MPC by 24 percent.

The last two columns in the left panel of Figure B1 show how this empirical estimate compares to those from the model and demonstrate the key role played by the persistent of the unemployment shock in determining this mechanism. The second column shows first the increase in the aggregate MPC that results from a 1-period aggregate shock. Since this is a 1-time purely transitory cash drop, the aggregate MPC in determined not by the *empirical* MPC but rather by the *transitory* MPC, which Table B1 showed was far below the empirical estimates. However, Table B1 also shows that these transitory MPCs are highly correlated with the empirical MPCs, and thus, the aggregate MPC in the actual case is larger than the aggregate MPC in the empirical case. Indeed, while the levels are lower than the empirical estimates, the percent increase in the aggregate MPC is even larger at 30 percent. In this model, while the persistence of the shock matters for the level of the aggregate MPC, it is not critical for the amount of amplification implied by the heterogeneous incidence of the shock.

Lastly, the final columns in the left panel of Figure B1 shows the aggregate MPC in response to a persistent aggregate shock. In period 1, agents receive their period 1 shock, but also anticipate that the shock will decay slowly and therefore may respond today to expected future changes income. I choose the persistence of the aggregate shock to match the persistence of the average unemployment spell, which is given by $\rho = 1 - 2\overline{f} = 0.34$. With this persistent shock, the aggregate benchmark MPC is much larger than with the transitory shock and very close to the empirical estimate in column 1. Importantly, the increase in the aggregate MPC across scenarios is large, similar in magnitude to the empirical estimate, and larger than in the transitory case in Column 2. When the shock is persistent and unevenly distributed in multiple periods, the same workers who face a large shock today also anticipate facing a larger shock in the next period, and thus the drop in their consumption today is even larger. The heterogeneous exposure of the future shock amplifies the heterogeneity today, and thus, the overall strength of this mechanism increases.[68]

The right panel of Figure B1 uses the simplified structure of the model and the derived expressions for the multiplier in Proposition 1 to explore how well the empirical matching multiplier from Section 2 captures the general-equilibrium effects on *output* in this dynamic setting. First, column 1 in the right panel reproduces the empirical estimate, which uses the empirical MPCs and the simplified 2-period formula for

[67] These numbers differ from those in Table 3 because they do not account for the existence of non-labor income. Therefore, I do not scale the benchmark MPC by the empirical average elasticity of income to GDP and I do not rescale the covariance by a measure of the labor share. This results in a larger baseline MPC and a larger level increase between the actual and benchmark scenarios. However, the percentage increase in the MPC in Figure B1 is similar to that in Table 3.

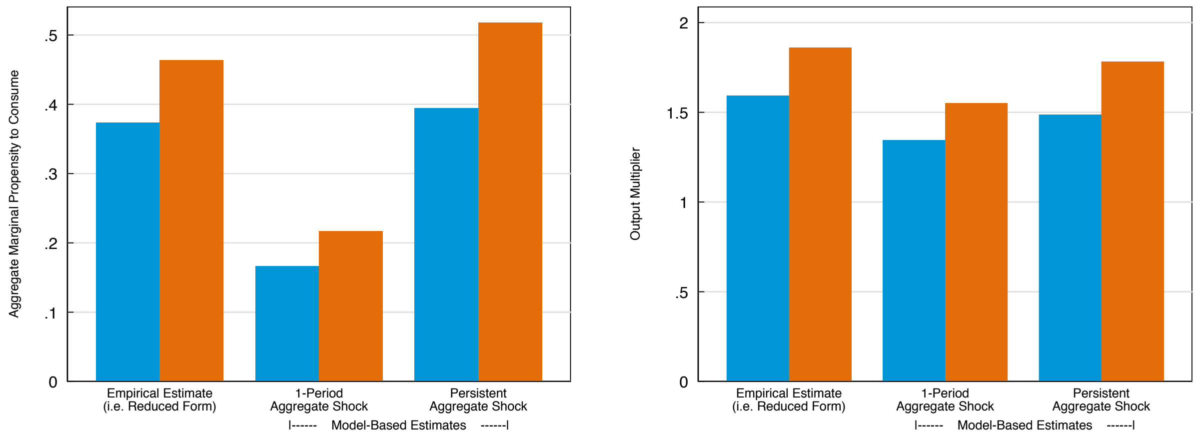
[68] It is important to note that this experiment captures the average persistence of the unemployment shock as in the data, but does not capture the heterogeneous persistence of the unemployment shock across individuals. If a large part of the heterogeneity in empirical MPCs across groups were driven by heterogeneity in the persistence of the unemployment shock, the amplification of the consumption response in the actual scenario in the model would be smaller than in the data. However, the amplification from the heterogeneous incidence is slightly larger in the model than in the data, suggesting, if anything, that the heterogeneous persistence of unemployment across individuals dampens the matching multiplier mechanism.

the multiplier. The following columns compare this to the model-based multipliers that take the dynamics of the model seriously, and are therefore based on the model-implied estimates of the intertemporal MPC matrix as in Auclert et al. (2018). Column 2 in the right panel corresponds to the scenario in column 2 in the left panel and shows the multiplier in response to a 1-period partial-equilibrium shock.[69] Since the level of the MPC is much lower, the level of the dynamic multiplier is also much lower in both the baseline and actual scenarios. However, still, the amplification implied by the heterogeneous incidence is meaningful, increasing the baseline multiplier by 21 percentage points, or 15 percent. Lastly, Column 3 in the right panel of Figure B1 shows the multiplier in response to a shock that has the persistence of the average unemployment spell. This column looks very similar to column 1, with a baseline multiplier of about 1.5 that is amplified by 20 percent with the heterogeneous incidence of the aggregate shock.

The analysis in both panels of Figure B1 demonstrate that the empirical matching multiplier used throughout the analysis, which was derived using MPCs out of persistent unemployment and a simplified 2-period multiplier closely approximates a dynamic multiplier of a persistent shock. Additionally, while the persistence of the shock is important for determining the level of the amplification, it is not the driver of the matching multiplier mechanism.

[69]For the estimates in both columns 2 and 3 of the right panel of Figure B1, I assume that wages are rationed (and thus prices are fixed) for 10 periods.

Figure B1: The Matching Multiplier in the Model



Notes: The blue bars refer to the "benchmark scenario" in which the shock is distributed such that all workers have an elasticity of 1. The red bars refer to the "actual scenario", where the shock is distributed such that the each worker has an elasticity determined by the empirical covariance between elasticities and empirical MPCs. The left panel shows the aggregate MPC across the two scenarios and the right panel shows the output multiplier across the two scenarios.

Table B1: Model Calibration by Demographic Group

	A: Unemployment		B: Earnings		C: Model Calibration			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	f	s	$\overline{\log(w)}$	Std. $\log(w)$	Std. $\log(y)$	Empirical MPC	β	Transitory MPC
High School or Less								
Non-Black Men	0.35	0.02	10.76	0.75	0.75	0.46	0.96	0.23
Black Men	0.26	0.03	10.44	0.79	0.80	0.79	0.85	0.57
Non-Black Women	0.31	0.01	10.12	0.87	0.87	0.55	0.94	0.29
Black Women	0.23	0.02	10.07	0.89	0.90	0.59	0.93	0.29
Some College or More								
Non-Black Men	0.32	0.01	11.17	0.84	0.85	0.31	0.98	0.11
Black Men	0.29	0.01	10.77	0.73	0.73	0.73	0.89	0.45
Non-Black Women	0.34	0.01	10.58	0.98	0.98	0.36	0.96	0.17
Black Women	0.27	0.01	10.44	0.84	0.85	0.47	0.96	0.20

Notes: Panel A reports the job-finding (f) and job-separation (s) rates calculated from the monthly basic Current Population Survey from 1994-2018 and defined as $f = \frac{UE}{UU+UE}$ and $s = \frac{EU}{EE+EU}$, where UE is the number of people transitioning across months form unemployment to employment, UU is the number of people from unemployment to unemployment, etc. Panel B reports the average log of earnings and the standard deviation of that log of earnings from the model's income process for the employed. This AR(1) income process is estimated to match the PSID data following the methodology in Heathcote et al. (2010). I include both the nationally representative sample and SEO subsample of the PSID and use individual labor rather than household earnings. Panel C shows parameters for the steady-state of the model. Column 5 reports the standard deviation of the overall earnings process for each group in the model. The empirical MPC in Column 6 is the earnings-weighted average MPC estimated in the PSID as described in Section 4.1. Column 7 reports the discount factor that is needed to match the earnings-weighted average MPC given the other parameters. Column 8 reports the earnings-weighted average transitory MPC in the model, which is defined as the increase in consumption per dollar increase in income.

Table B2: Additional Statistics for Unemployment Process

			Unemployment Rate		Unemployment Duration			Earnings Recovery (X)	
	f	s	Model	CPS	Model	CPS	PSID	Model	PSID
High School or Less									
Non-Black Men	0.35	0.35	0.05	0.05	2.85	5.16	3.32	0.68	0.66
Black Men	0.26	0.26	0.09	0.09	3.78	6.66	3.84	0.60	0.80
Non-Black Women	0.31	0.31	0.04	0.04	3.19	5.19	2.44	0.65	0.57
Black Women	0.23	0.23	0.08	0.08	4.42	6.51	3.37	0.55	0.55
Some College or More									
Non-Black Men	0.32	0.32	0.02	0.03	3.16	5.55	2.36	0.65	0.63
Black Men	0.29	0.29	0.05	0.05	3.44	6.30	2.61	0.62	0.64
Non-Black Women	0.34	0.34	0.02	0.03	2.92	4.93	2.15	0.67	0.49
Black Women	0.27	0.27	0.04	0.05	3.72	6.19	2.80	0.60	0.63

Notes: Columns 1 and 2 report the average monthly job finding (f) and job separation (s) rates , respectively, calculated from the matched monthly basic CPS. Column 3 reports the unemployment rate implied by the job-finding and job separation rate ($u = \frac{s}{s+f}$) while Column 4 reports the average monthly unemployment rate in the CPS. Column 5 reports the average unemployment duration implied by the job-finding rate ($\frac{1}{f}$) while column 6 reports the average unemployment duration (in months) in the CPS. Column 8 reports the average number of months in a year that someone who is unemployed at the time of the survey will be unemployed for in the PSID. Unlike the estimate in Column 7, this measure is not restricted to a continuous unemployment spell and is truncated at 52 weeks. Lastly, Column 8 reports the model-based fraction of earnings captured by those in the unemployment state, which is the result of a simulated earnings process with 10,000 individuals and 30 years of earnings. Column 9 reports the percentage difference in annual earnings for the unemployed and employed in the PSID. This is estimated on the sample used for the MPC estimation and described in detail in Section 4.1.