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Time Use and Consumption Expenditures*

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Abstract

This paper documents large heterogeneity in the cyclicality of expenditure items within aggregate consumption and shows that a substantial part of this heterogeneity can be explained by differences in the household time required to consume. Combining data from the American Time Use Survey and Personal Consumption Expenditures, we construct a set of consumption activities and establish new stylized facts. We show that in a recession consumption expenditures fall to a greater extent for those activities to which households reallocate a larger share of foregone market hours, suggesting that time and expenditures are substitutes. We develop a two-sector New Keynesian model that rationalizes these patterns. Disciplining the model with microeconomic estimates of the elasticity of substitution between time and expenditures and of price stickiness, we find that our model accounts for roughly forty percent of the impact expenditure response to monetary policy shocks.

Keywords: Business Cyle, Monetary Policy, Time Use, Home Production, Consumption Expenditures
JEL Codes: D12; E21; E32; E52; J22

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1. Introduction

Private consumption, traditionally measured in the United States by Personal Consumption Expenditures (PCE), accounts for roughly two-thirds of GDP in most developed countries and declines sharply during recessions. While less cyclical than investment, consumption still fluctuates enough with the broader economy to raise concerns for social welfare. This cyclicality has inspired extensive macroeconomic research, starting with the foundational work of Kydland and Prescott (1982) and Long and Plosser (1983).

This paper takes this literature a step further by examining consumption cyclicality through a novel and finer classification of expenditures. Existing work has shown that broad consumption categories, such as necessities and luxuries, display distinct cyclical properties (Aguiar and Bils, 2015; Orchard, 2022; Andreolli et al., 2024), highlighting the importance of compositional shifts when assessing the welfare consequences of business-cycle fluctuations. We build on this insight by asking whether differences in consumption cyclicality extend beyond the broad expenditure categories already considered in the literature.

To examine expenditures at a more granular level, we propose to interpret and rationalize the data through the lens of a Beckerian model of consumption, both empirically and theoretically. Becker (1965) argued that, rather than being mere expenditure, consumption is an activity that occurs at the household level, where goods and services purchased on the market are combined with time. To operationalize this idea, we match PCE expenditure items to American Time Use Survey (ATUS) categories and construct consumption activities that combine a market expenditure input with the corresponding household time input.[1]

We make two key contributions. First, from an empirical standpoint, we document new stylized facts on the joint business-cycle behavior of household time and consumption expenditures. Linking the two inputs at the activity level, we show that activities toward which households reallocate more time when market work falls also tend to experience larger relative expenditure contractions. Second, we show that an otherwise standard New-Keynesian model with time use and homothetic preferences can rationalize this heterogeneity through differences across consumption activities in time intensity and in the elasticity of substitution between time and expenditures. Our novel approach offers a more granular, activity-based account of consumption cyclicality, complementing existing explanations based on broad categories such as necessities and luxuries by showing how household time helps shape the cyclicality of market expenditures. More broadly, the results suggest that the business-cycle

[1] We focus on ten activities: Cooking, Cleaning, Eating and Drinking; TV, Radio, and Music; Animals and Pets; Socializing, Relaxing, and Hobbies; Personal Care; Home Maintenance and Gardening; Travel (as a form of entertainment); Sports and Exercise; Household Management; and Entertainment.

behavior of consumption cannot be understood from expenditures alone: it also depends on how households reallocate the time required to consume.

After organizing data at the activity level, we measure time intensity, time cyclicality, and expenditure cyclicality across activities. The main empirical finding is that consumption activities with more cyclical real expenditures also tend to have more cyclical time inputs. This fact emerges consistently across the different business-cycle statistics we consider, including average behavior during recessions, correlations with GDP at business-cycle frequencies, and responses to identified monetary policy shocks. During downturns, households reduce consumption expenditures and reallocate time away from market work, but these adjustments are highly uneven across activities. Expenditure cuts are largest for activities toward which households reallocate relatively more time. At the same time, the relationship is weaker when time intensity is low: activities in which household time is a relatively small input can display highly cyclical time use without equally cyclical expenditures. For instance, expenditures on Sports and Exercise contract disproportionately as time is reallocated toward that activity, whereas Entertainment, which has low time intensity, moves more closely with total consumption expenditures. The evidence therefore points to a systematic but imperfect link between the cyclicality of household time and the cyclicality of market expenditures at the activity level.

These facts point to two activity-level margins that may shape the joint cyclicality of household time and market expenditures: time intensity and the elasticity of substitution between time and expenditures. The model formalizes these margins and shows how they can rationalize both the positive association between time and expenditure cyclicality and the weaker link observed for low-time-intensity activities. We discipline the substitution margin by combining expenditure data from the Consumer Expenditure Survey (CEX) with time-use data from ATUS to estimate activity-level elasticities between time and expenditures. Quantitatively, the calibrated model shows that this channel alone accounts for a sizable share of the impact expenditure responses to monetary policy shocks, roughly two-fifths in the baseline calibration.

We relate these findings to two strands of literature. First, we contribute to the literature on heterogeneity in consumption cyclicality. A growing body of work shows that consumption categories differ systematically over the business cycle, with necessities and luxuries, or essential and non-essential expenditures, displaying different cyclical properties (Aguiar and Bils, 2015; Orchard, 2022; Andreolli et al., 2024). Our contribution is to provide a more granular, activity-based account of consumption cyclicality by linking market expenditures to the household time required to consume them. Second, we contribute to the time-use literature, which shows that households reallocate time away from market work and toward

nonmarket activities over the business cycle (Aguiar et al., 2013 (AHK); Gnocchi et al., 2016; Cacciatore et al., 2024 (CGH)). We add to this literature by showing that these time reallocations are systematically related to the cyclicality of market expenditures at the activity level. Taken together, our results suggest that the composition of consumption over the business cycle cannot be fully understood from expenditures alone: household time is an important margin shaping how consumption adjusts across activities. Our activity-based perspective points to questions beyond the scope of the present paper. It suggests future work on cost-of-living measurement when household time is an input into consumption, and on optimal monetary policy in economies where time-use margins affect the welfare costs of sectoral nominal rigidities.

2. Time Use and Consumption Expenditures in the Data

This section studies the joint business-cycle behavior of time use and real consumption expenditures. We interpret compositional changes in the PCE through a Beckerian lens, treating consumption as the outcome of activities that combine goods and services purchased on the market with the household's time. The analysis has three components. First, we construct consumption activities by combining time-use data from ATUS 2003–2019 with expenditure data from the PCE.[2] Second, we compute activity-level statistics, including time intensity, defined as average weekly minutes per unit of expenditure; the cyclicality of time input; and several measures of the cyclicality of real expenditure input. Third, we relate the cyclicality of real expenditures to the time-content characteristics of activities.

Our main empirical finding is that the cyclicality of consumption expenditures is systematically related to the cyclicality of time use: activities with more cyclical time inputs also display more cyclical expenditures, both unconditionally and following monetary policy shocks. This relationship operates through the time content of consumption: it strengthens with time intensity and necessarily disappears when time plays no role. We also show that substantial heterogeneity remains within broad categories such as home production and leisure, suggesting that activity-level time inputs reveal variation masked by coarser classifications.

This finding connects two strands of evidence that previous research has largely examined separately. On the time-use side, recessions reallocate time toward nonmarket work

[2] We take Personal Consumption Expenditures and the corresponding price indices from NIPA Tables 2.8.5 and 2.8.4. Price indices for activities are constructed as Fisher indices, following the BEA NIPA Handbook. The ATUS is a pooled cross-section, with respondents drawn from the CPS outgoing rotation group and interviewed once. We use data from 2003–2019, restricting the sample to respondents aged 18–65.

(Aguiar et al., 2013; Cacciatore et al., 2024). On the expenditure side, downturns reshape expenditure composition away from goods and luxuries and toward services and necessities (Orchard, 2022; Andreolli et al., 2024). Our contribution is to show that these adjustments are systematically linked at the activity level.

2.1. Definition of Activities

We construct consumption activities by aggregating ATUS codes to the level at which they can be consistently matched to PCE expenditure items. A detailed mapping of ATUS codes and expenditure items into consumption activities is provided in Appendix A. As an illustration, consider "Cooking, Cleaning, Eating, and Drinking." We first construct the relevant time input by aggregating ATUS codes associated with housework, food and drink preparation, grocery shopping, travel related to grocery shopping, eating, and drinking. We then construct the corresponding expenditure input by linking this activity to specific PCE items, including food and nonalcoholic beverages, household supplies, household appliances, food services, and domestic services.

We partition the individuals 168-hour weekly time endowment across activities and construct the corresponding expenditure input from PCE items.[3] Some expenditures, such as motor vehicles, clothing and footwear, and internet or mobile phone services, enter more than one activity. We allocate them in proportion to their average time inputs over 2003–2019. Overall, we identify 16 consumption activities. Our analysis focuses on a core set of 10, excluding those that either require negligible expenditures, such as sleep, or do not map cleanly into our framework, such as education and health, which would be better represented as household's investment or non-discretionary spending.[4] Excluding sleep, the core set and market work together account for 89% of weekly hours, with the remaining 11% allocated to excluded activities.[5] In terms of real expenditures, the core set accounts for 70% of household real consumption, while excluded activities account for the remaining 30%.

[3]We exclude the following expenditure items: financial services, insurance, net expenditures abroad by U.S. residents, net foreign travel, and final consumption of nonprofit institutions serving households. These exclusions account for only 9% of monthly PCE, leaving our measure to encompass 91% of total consumption expenditures.

[4]The excluded activities are: Sleeping, which requires only time input; Health, accidents, and emergencies; Education; Child care; Care of others and social services; and Civic and religious activities.

[5]Including sleep, the core set and market work account for 57% of weekly hours, with excluded uses accounting for the remaining 43%. Sleep, the most time-intensive activity, accounts for 36% of weekly hours.

2.2. Time Intensity

A central feature of any activity is how much time households devote to it relative to market inputs. We define and measure activity-level time intensity as weekly minutes of time input per unit of real expenditure, building on Gronau and Hamermesh (2006), while working at a more disaggregated level. We obtain average weekly time input from the ATUS (Column (1) of Table 1) and compute average weekly real per-capita expenditures (Column (2)) from the PCE, deflating nominal expenditures by the total PCE price index. Time intensity is then computed as the ratio of time to expenditures, after expressing time in minutes.

Time intensity varies substantially across activities. It is highest for TV, Radio, and Music, at 4.91 minutes per unit of real expenditure, and Socializing, Relaxing, and Hobbies, at 3.20. It is much lower for Entertainment, at 0.97, and Household Management, at 1.55. These differences are even more pronounced when we use activity-specific expenditures that exclude proportionally allocated items, such as housing and car-related costs; see Table B.1 in Appendix B.[6]

Activity	Weekly Hours (1)	Weekly Real Expenditure (2)	Time Intensity (min per unit) (3)
Entertainment	1.19	73.24	0.97
Household Management	1.71	66.31	1.55
Cooking, Cleaning, Eating, Drinking	17.88	665.30	1.61
Travel (as a form of entertainment)	0.42	15.61	1.61
Animals and Pets	0.93	33.37	1.67
Home Maintenance and Gardening	2.87	102.91	1.68
Sports and Exercise	2.42	72.89	1.99
Personal Care	5.27	128.25	2.47
Socializing, Relaxing and Hobbies	12.99	243.31	3.20
TV, Radio, Music	18.36	224.19	4.91

Table 1: Time Intensity across Consumption Activities. Column (1) reports average weekly hours from ATUS. Column (2) reports average weekly real per-capita consumption expenditures, including proportional expenditures (nominal expenditures deflated by the total PCE price index, base year 2012). Column (3) reports time intensity, defined as average weekly minutes per unit of real expenditure. Activities are sorted by ascending time intensity. Sample period: 2003–2019.

[6]The ranking by time intensity is robust to the choice of deflator: when deflating nominal expenditures by the activity-level price index P_j rather than the total price index P, the full ranking is preserved. Table B.2 in Appendix B reports this P_j-deflated version of Table 1.

2.3. Time Cyclicality

Following CGH and AHK, we exploit cross-state variation in the United States to control for low-frequency trends in time use and isolate cyclical changes in the allocation of time across activities. Since market work is strongly procyclical, we use changes in market hours as a proxy for changes in local economic conditions. We measure the cyclical co-movement between activity-level time input and market work by estimating

$$\Delta\tau^{j}_{s,t} = \alpha^{j} - \beta^{j}\Delta\tau^{market}_{s,t} + \gamma\Delta Z_{s,t} + \varepsilon^{j}_{s,t}, \tag{1}$$

where $\Delta\tau^{j}_{s,t}$, which denotes the year-over-year change in average time spent on activity j in state s, measured at quarterly frequency, and $\Delta\tau^{market}_{s,t}$, the corresponding change in market work, are computed by aggregating time at the state level across individuals, hence treating the data as a pseudo-panel. The vector $\Delta Z_{s,t}$ controls for changes in state-level demographics.[7] We estimate the regression by weighted least squares, weighting states by population. We are interested in the time reallocation coefficient β^{j}: because market work enters with a negative sign, a positive value measures the share of foregone market hours reallocated to activity j when market work declines. By construction, summing β^{j} across the exhaustive set of activities gives one.

We convert the reallocation coefficient $\hat{\beta}^{j}$ into a time-use elasticity with respect to market work, defined as $\varepsilon^{j} \equiv \hat{\beta}^{j}\tau^{market}/\tau^{j}$, where τ^{market} denotes average market hours and τ^{j} average time devoted to activity j, both computed over 2003–2019. This transformation expresses the reallocation response in percentage terms: following a 1 percent decline in market hours, time spent on activity j increases by ε^{j} percent. We use ε^{j} as our measure of time cyclicality across activities, while refraining from giving it any structural interpretation.

Table 2 ranks activities by time cyclicality, showing substantial heterogeneity.[8] In a recession, when market hours decline, time is reallocated disproportionately toward more elastic margins, such as Sports and Exercise (0.52) and Home Maintenance and Gardening (0.53), whose time inputs increase more strongly in percentage terms. By contrast, activities such as Animals and Pets (0.28), Cooking, Cleaning, Eating, and Drinking (0.23), and Personal Care (-0.07) display much weaker responses. While CGH and AHK emphasize that housework is more elastic than leisure, our finer disaggregation shows that this distinction masks substantial within-group heterogeneity: some leisure activities are highly elastic, whereas some forms of nonmarket work are not.

[7] Following AHK, we control for age, education, race, marital status, and the number of children.

[8] Table B.3 in Appendix B reports estimates for all sixteen activities, including those excluded from the core set.

Activity	Time Reallocation Coefficient $\hat{\beta}^j$ (1)	Time Cyclicality ε^j (2)
Entertainment	0.021 (0.003)	0.53
Home Maintenance and Gardening	0.053 (0.005)	0.53
Sports and Exercise	0.041 (0.004)	0.52
Travel (as a form of entertainment)	0.007 (0.002)	0.48
Household Management	0.025 (0.003)	0.43
Socializing, Relaxing and Hobbies	0.164 (0.009)	0.39
TV, Radio, Music	0.204 (0.009)	0.35
Animals and Pets	0.009 (0.002)	0.28
Cooking, Cleaning, Eating, Drinking	0.132 (0.006)	0.23
Personal Care	-0.012 (0.002)	-0.07

Table 2: Time Cyclicality across Consumption Activities. Column (1) reports the estimated time reallocation coefficient between market hours and time spent on each activity ($\hat{\beta}^j$), based on the AHK regression using year-over-year changes at quarterly frequency, with standard errors in parentheses. All coefficients are statistically significant at the 1% level. Column (2) presents the implied time-use elasticities. Sample period: 2003–2019.

2.4. The Joint Cyclicality of Time and Expenditure Inputs

We now measure the cyclicality of activity-level expenditures and relate it to two time-use characteristics: time intensity and time cyclicality. Table 3 ranks activities by the correlation between GDP and the ratio of activity-level to aggregate expenditures. The three activities with the most cyclical time inputs—Sports and Exercise, Travel, and Home Maintenance and Gardening—also display the strongest cyclicality on the expenditure side. This pattern weakens among activities with weakly cyclical time inputs—such as Cooking, Cleaning, Eating and Drinking—or low time intensity—such as Household Management, suggesting that the cyclicality of time and expenditures is more closely linked when time is an important input in consumption. Entertainment illustrates this point sharply: although its time cyclicality is among the highest in the sample (0.53), spending on activities such as concerts, movies, and sporting events shows a near-zero expenditure-GDP correlation (-0.04), reflecting its low time intensity (0.97, the lowest in the sample).

A similar pattern emerges from the average behavior of expenditures during recessions. Figure 1 plots the change in real consumption expenditures over the course of recessions between 1980 and 2019. The steepest declines occur for activities with highly cyclical time inputs, shown in the left panel. By contrast, activities with either low time cyclicality or

Activity	Correlation btw. Expenditure Ratios and GDP (1)	Time Intensity (2)	Time Cyclicality ε^j (3)
Sports and Exercise	0.76	1.99	0.52
Travel (as a form of entertainment)	0.73	1.61	0.48
Home Maintenance and Gardening	0.69	1.68	0.53
Personal Care	0.63	2.47	-0.07
Socializing, Relaxing and Hobbies	0.55	3.20	0.39
Animals and Pets	0.51	1.67	0.28
TV, Radio, Music	0.33	4.91	0.35
Cooking, Cleaning, Eating, Drinking	0.29	1.61	0.23
Entertainment	-0.04	0.97	0.53
Household Management	-0.02	1.55	0.43

Table 3: Expenditure Cyclicality across Consumption Activities. Column (1) reports the correlation between GDP and the ratio of activity-level to aggregate real expenditures, using log-detrended PCE data from 1980Q1 to 2019Q4. Expenditure and price series are detrended with the filter in Christiano and Fitzgerald (2003). Columns (2) and (3) reproduce time intensity and time cyclicality from Tables 1 and 2, respectively.

low time intensity move more closely with overall PCE consumption, as shown in the right panel.[9]

Overall, recessions are characterized by declines in both market hours and consumption expenditures, but these adjustments are not uniform across activities. Expenditure cuts are largest for activities in which time input rises the most, suggesting that households partly offset lower market expenditures by reallocating time toward those same activities.

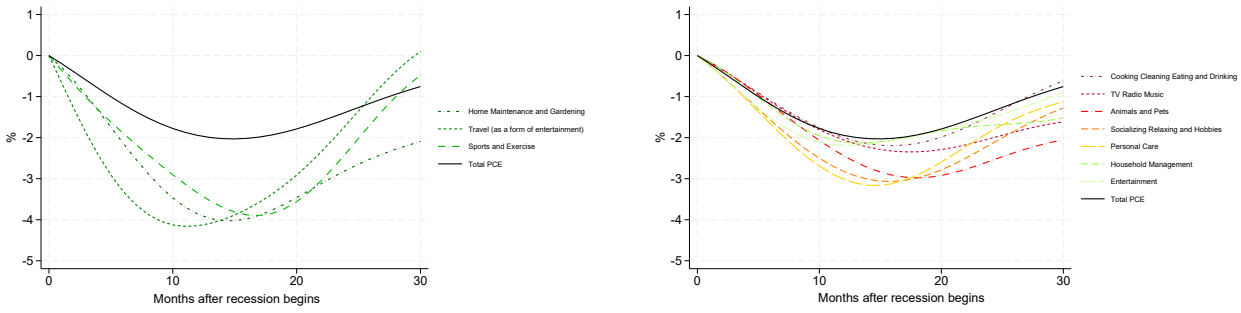


Figure 1: Average change in real consumer expenditures following the start of a recession, based on log-detrended PCE data from 1980M1 to 2019M12. The figure plots the average decline in expenditures for each activity across all NBER-defined recessions.

[9]Health-related expenditures—the largest excluded expenditure category—are notably less cyclical than our core consumption activities, explaining why all activity lines lie below total PCE during recessions.

2.5. Joint Time–Expenditure Cyclicality after Monetary Policy Shocks

The previous section documents a novel fact: consumption activities with more cyclical time use also display more cyclical expenditures, especially when time plays an important role in consumption. We now show that the same joint cyclicality emerges conditional on monetary policy shocks.

Monetary policy shocks provide a useful source of variation for our purposes because they primarily affect real activity and quantities, while leaving relative prices largely unaffected.[10] They therefore allow us to better identify the contribution of time reallocation to heterogeneity in real expenditure responses across activities, while limiting the role of relative-price effects.[11]

Following Mertens and Ravn (2013) and Stock and Watson (2018), we estimate a separate proxy VAR for each consumption activity. We use the high-frequency monetary policy surprises of Bauer and Swanson (2023), available from 1988 to 2019, as an external instrument for monetary policy shocks. These surprises capture movements in market interest rates around policy announcements, and we exploit this information within an SVAR framework to identify monetary policy shocks.

The endogenous variables are the one-year government bond yield, log industrial production, log total real personal consumption expenditures, the log total PCE price index, the excess bond premium of Gilchrist and Zakrajšek (2012), log activity-level real expenditures relative to total PCE, and the log activity-level Fisher price index relative to the aggregate PCE price index. The model includes six lags of the endogenous variables and is estimated on monthly data from February 1988 to December 2019.

The results reinforce our earlier findings. Figure 2 reports impulse response functions for real consumption expenditures across activities following a contractionary monetary policy shock that raises the one-year government bond yield by 100 basis points. Expenditures decline more sharply for activities with highly cyclical time inputs, shown in the top panel, such as Sports and Exercise, Travel, and Home Maintenance and Gardening.

By contrast, expenditures in activities with weakly cyclical time inputs—such as Cooking, Cleaning, Eating and Drinking, or TV, Radio, and Music—or low time intensity—such as

[10] While price responses display substantial cross-sectional heterogeneity, monetary policy shocks account for only a limited share of their variation relative to sector-specific disturbances; see, for example, Boivin et al. (2009); Maćkowiak et al. (2009). More recent evidence points to larger cross-sectional dispersion than previously documented (Aruoba and Drechsel, 2024).

[11] In our estimates as well, relative-price responses are heterogeneous but not systematically related to expenditure dynamics, so we report them in the appendix and focus here on real expenditures and time inputs. Figure B.2 in Appendix B plots relative-price dynamics for all activities. Figure B.3 inAppendix B shows relative-price dynamics for the two bundles, defined by high and low time-cyclicality.

Household Management, and Entertainment—all displayed in the bottom panel, move more closely with total expenditures.

Categorizing activities into home production and leisure reveals that the most sensitive expenditures—those experiencing the largest drop after a contractionary monetary policy shock—are clearly classified as leisure following Aguiar et al. (2013) (e.g., Sports and Exercise; Travel; Socializing, Relaxing, and Hobbies). However, not all leisure activities follow this pattern; for instance, spending on Entertainment moves in line with total expenditures. A similar nuance exists within home production. While spending on core home production activities—such as Cooking, Cleaning, Eating and Drinking, and Household Management—remains stable relative to total consumption, expenditures on other nonmarket activities, notably Home Maintenance and Gardening, decline disproportionately. This highlights significant heterogeneity within these broad categories, underscoring the need for finer disaggregation and for considering the activity-specific characteristics discussed earlier, such as time cyclicality and time intensity.

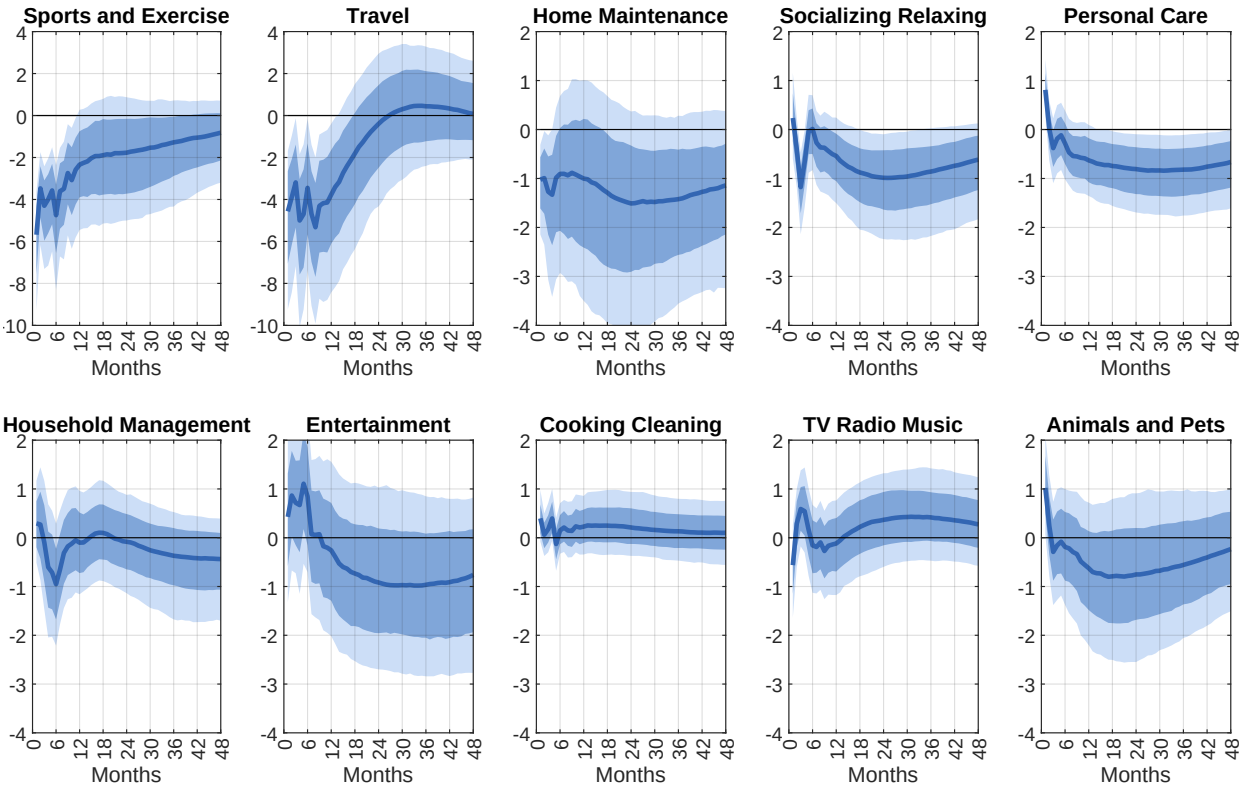


Figure 2: Estimated impulse responses of activity-level real expenditures, relative to total, following a contractionary monetary policy shock. Shaded areas denote 90% and 68% confidence intervals. the responses are estimated using monthly data from 1988:02–2019:12, with the shock—based on Bauer and Swanson, 2023—normalized to a 100 basis-point increase in the one-year government bond yield.

To further illustrate our point, we split activities into two bundles according to time cycli-

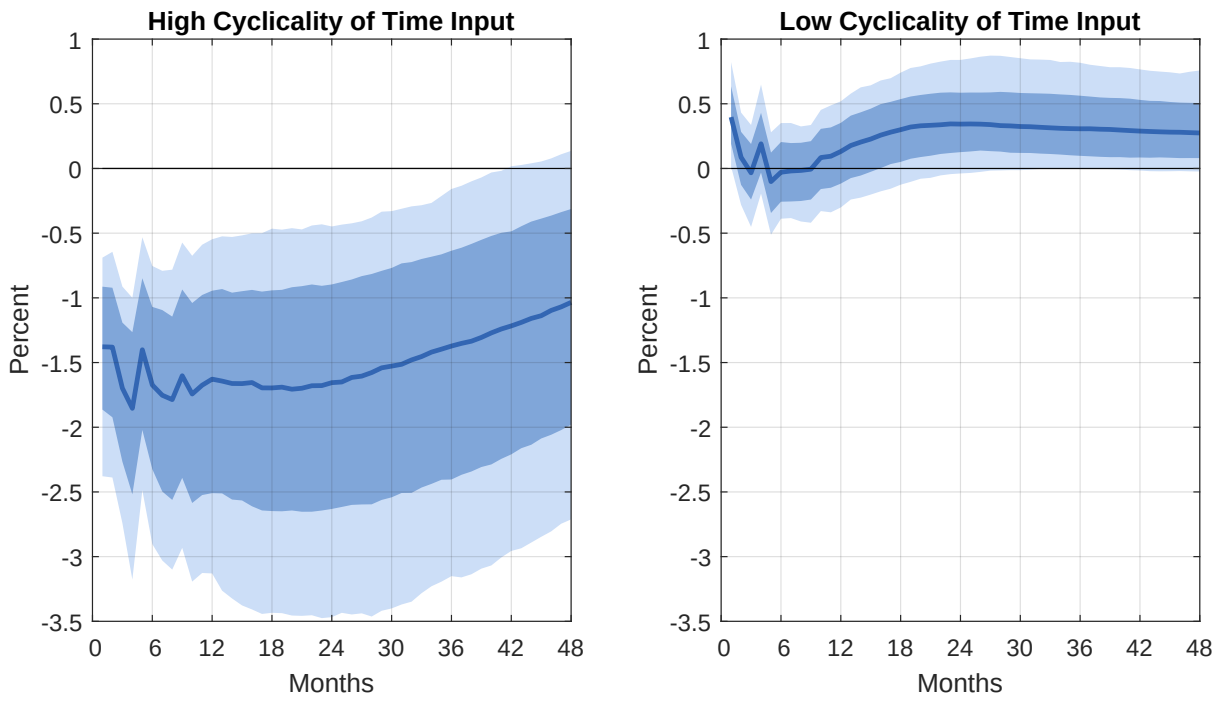


Figure 3: Estimated impulse responses of real consumption expenditures, relative to total real consumption expenditures, for activities with strongly and weakly cyclical time inputs, following a contractionary monetary policy shock. Shaded areas denote 90% and 68% confidence intervals. The responses are estimated using monthly data from 1988:02–2019:12, with the shock—taken from Bauer and Swanson, 2023—normalized to a 100 basis-point increase in the one-year government bond yield.

cality, using a cutoff of $\varepsilon = 0.4$, and then repeat the exercise of Figure 2. The high-cyclicality bundle comprises Entertainment; Home Maintenance and Gardening; Sports and Exercise; Travel; and Household Management; the remaining activities—Socializing, Relaxing and Hobbies; TV, Radio, Music; Animals and Pets; Cooking, Cleaning, Eating, Drinking; and Personal Care—form the low-cyclicality bundle. Figure 3 reports impulse response functions following a contractionary monetary policy shock for real consumption expenditures at the bundle level: expenditures again fall disproportionately for activities with strongly cyclical time inputs following a contractionary monetary policy shock. These dynamics become even more pronounced when excluding proportional components.[12]

Overall, our analysis establishes two novel facts: consumption activities with more cyclical time use also exhibit more cyclical expenditures, both unconditionally and conditional on monetary policy shocks; and substantial heterogeneity across activities remains within

[12]See Appendix B, Figure B.1. Results are robust using instrumental variable local projections, or using alternative proxy measures for monetary policy surprises, such as the the series proposed by Gertler and Karadi (2015), Jarociński and Karadi (2020), and Miranda-Agrippino and Ricco (2021). Results are also robust to alternative cutoffs ($\varepsilon = 0.3$ or $\varepsilon = 0.5$).

the broader categories of home production and leisure. Our activity-based classification is distinct from standard expenditure classifications, such as goods versus services or necessities versus luxuries.[13] In the next section, we develop a two-sector New Keynesian model with time use that rationalizes these findings and explores their implications for the transmission of monetary policy.

3. A Two-Sector New-Keynesian Model with Time Use

This section extends a standard two-sector New Keynesian model by incorporating household time as an input into consumption, following the Beckerian view of consumption as the output of activities that combine market goods and time (Becker, 1965).[14] In this framework, consumption activities may differ in the extent to which they require market expenditures and household time to generate utility. This activity-based formulation differs from the workhorse home-production model of Benhabib et al. (1991), which separates market consumption from nonmarket consumption produced within the household. Our setup nests this logic as a limiting case in which some activities rely primarily on market expenditures while others rely primarily on household time. More generally, the Beckerian perspective allows for heterogeneity across activities in how time and market goods combine to produce consumption, providing a framework that directly links the cyclicality of time inputs to the cyclicality of consumption expenditures.

We do not impose a sharp distinction between housework and leisure. In much of the time-use literature, housework denotes time used to produce nonmarket goods and services that could, in principle, be replaced by market purchases, while leisure denotes time valued directly by the household. This distinction is not central for our purposes. Our empirical framework matches time and expenditures at the activity level, and many activities may contain both instrumental and directly valued time components. Rather than classify activities ex ante as housework or leisure, we allow the degree of substitutability between time and expenditures to vary across activities and let the data discipline the relevant parameters.

For comparability with the literature, the model allows for leisure time that yields utility outside consumption activities. In the quantitative calibration, however, the relevant time

[13] Our time-based classification does not coincide with standard goods–services or necessity–luxury distinctions. The high time-cyclicality bundle is service-intensive (70% services), while the low time-cyclicality bundle is balanced between services and goods (48% services). Since services are typically less cyclical, this distinction cannot explain our results. The high time-cyclicality bundle also contains more luxuries than the low time-cyclicality bundle (64% vs. 45%, following Aguiar and Bils (2015)), suggesting partial but incomplete overlap with income-elastic consumption categories.

[14] See Appendix C for the model derivations, and Appendix D for the definition of the general equilibrium.

aggregate is constructed consistently with our empirical activity bundles, so this residual leisure component is set to zero.

3.1. The Household's Problem

Households start every period $t \geq 0$ with a time endowment that is normalized to 1 and a portfolio of state-contingent nominal assets B_t. Financial markets are complete and households are price takers in all markets. Time can be allocated either to market work, $h_{m,t}$, in exchange for a nominal wage, W_t, or to two consumption activities, $C_{1,t}$ and $C_{2,t}$:

$$C_{j,t} = \left[\alpha_j X_{j,t}^{b_j} + (1-\alpha_j) h_{j,t}^{b_j}\right]^{\frac{1}{b_j}}, \quad b_j < 1, \quad \alpha_j \in [0,1], \quad j \in \{1,2\}, \tag{2}$$

where $h_{j,t}$ is the time input and $X_{j,t}$ is the bundle of goods and services combined with it in activity j. Bundles are Dixit-Stiglitz aggregators,

$$X_{j,t} \;=\; \left[\int_0^1 \left(X_{j,t}(i)\right)^{\frac{\varepsilon_j - 1}{\varepsilon_j}} \, di\right]^{\frac{\varepsilon_j}{\varepsilon_j - 1}}, \quad \varepsilon_j > 1, \tag{3}$$

of goods and services that the household purchases on the market at their respective prices $P_{j,t}(i)$. Consumption activities are substitutable at a rate $1/(1-b)$ and can be aggregated into a total consumption bundle,

$$C_t = \left[\alpha C_{1,t}^b + (1-\alpha) C_{2,t}^b\right]^{\frac{1}{b}}, \quad b < 1. \tag{4}$$

Consumption yields utility together with any residual time, l_t, which is not assigned to market work or consumption activities, according to an instantaneous utility function $U(C_t, l_t)$ that is thrice differentiable and satisfies the standard assumptions.[15] Households allocate time and income to consumption so as to maximize lifetime utility

$$\mathbb{E}_t \sum_{t=0}^{\infty} \beta^t U(C_t, l_t), \qquad \beta \in (0,1), \tag{5}$$

subject to time and budget constrains,

$$h_t = h_{m,t} + h_{n,t}, \quad h_{n,t} = h_{1,t} + h_{2,t}, \quad l_t = 1 - h_t, \tag{6}$$

[15] Referring to l as leisure may be misleading in our context, because what time use data label as leisure may well be captured by h_1 and h_2. A parametrization with nil cross second-order partial derivatives $U_{C,l} = U_{l,C} = 0$, for the case where U_l is not identically nil, captures the case where time is valued above and beyond its use in consumption activities and it is neither complement nor substitute with real expenditures.

$$B_t + W_t h_{m,t} + T_t \geq \mathbb{E}_t \left\{ Q_{t,t+1} B_{t+1} \right\} + \sum_{j=1}^{2} P_{j,t} X_{j,t}, \tag{7}$$

where T_t denotes lump-sum taxes and transfers, including firms' profits, $Q_{t,t+1}$ is the stochastic discount factor for one-period-ahead nominal payoffs, B_{t+1} is the portfolio of state-contingent assets that households carry to the next period, and price indices $P_{j,t}$,

$$P_{j,t} = \left[\int_0^1 \left(P_{j,t}(i) \right)^{1-\varepsilon_j} \, di \right]^{\frac{1}{1-\varepsilon_j}}, \tag{8}$$

are implied by the optimality of expenditure allocation across varieties[16]

Before turning to the optimality conditions, it may be useful to notice that the household's problem nests various cases previously studied in the literature. The consumer problem reduces to the one in the standard one-sector business cycle model for $\alpha = \alpha_1 = 1$ (Galí (2008); Woodford (2003)), whereas the case of a two-sector model without home production obtains if $\alpha_1 = \alpha_2 = 1$ and $\alpha \in (0, 1)$.[17] Setting $\alpha_1 = 1$ and $\alpha_2 = 0$ represents the case of a model with home production as in (Benhabib et al. (1991); Gomme et al. (2001); Gnocchi et al. (2016); Cacciatore et al. (2024)), where C_1 is a good purchased on the market, C_2 is a home-produced good, the home production function is linear in housework, and the elasticity of substitution between market and home-produced goods is $1/(1-b)$. Our model thus extends an otherwise standard two-sector business cycle model by incorporating the idea that all consumption goods are, to some degree, home-produced—a perspective originally introduced by Becker (1965).

Define for convenience

$$\lambda_{1,t} \equiv \alpha U_C(C_t, l_t) \left(\frac{C_{1,t}}{C_t} \right)^{b-1} \alpha_1 \left(\frac{X_{1,t}}{C_{1,t}} \right)^{b_1 - 1}, \tag{9}$$

and

$$\lambda_{2,t} \equiv (1-\alpha) U_C(C_t, l_t) \left(\frac{C_{2,t}}{C_t} \right)^{b-1} \alpha_2 \left(\frac{X_{2,t}}{C_{2,t}} \right)^{b_2 - 1}, \tag{10}$$

which represent marginal utilities of real consumption expenditures, $X_{1,t}$ and $X_{2,t}$, respec-

[16] The stochastic discount factor in period t is the price of a bond that delivers one unit of currency if a given state of the world realizes in period $t+1$, divided by the conditional probability that the state of the world occurs given the information available in t. The nominal interest rate, i_t, relates to the discount factor according to $(1 + i_t) = \{\mathbb{E}_t Q_{t,t+1}\}^{-1}$.

[17] See e.g., Aoki (2001); Benigno (2004); Chapter 6 in Woodford (2003); Bouakez et al. (2009); Wolman (2011); Ruge-Murcia and Wolman (2022); and Afrouzi et al. (2024).

tively. Optimality implies the following first-order conditions:

$$\frac{P_{1,t}}{P_{2,t}} = \frac{\lambda_{1,t}}{\lambda_{2,t}}, \tag{11}$$

$$\beta(1+i_t)\mathbb{E}_t\left\{\frac{\lambda_{1,t+1}}{\lambda_{1,t}}\Pi_{1,t+1}^{-1}\right\} = 1, \tag{12}$$

$$\frac{U_l(C_t, l_t)}{\lambda_{1,t}} = \frac{W_t}{P_{1,t}}, \tag{13}$$

$$\frac{W_t}{P_{1,t}} = \frac{1-\alpha_1}{\alpha_1}\left(\frac{X_{1,t}}{h_{1,t}}\right)^{1-b_1}, \tag{14}$$

$$\frac{W_t}{P_{1,t}}\frac{P_{1,t}}{P_{2,t}} = \frac{1-\alpha_2}{\alpha_2}\left(\frac{X_{2,t}}{h_{2,t}}\right)^{1-b_2}, \tag{15}$$

where $\Pi_{j,t} \equiv P_{j,t}/P_{j,t-1}$ denotes inflation of price $P_{j,t}$. The first three equations are standard in two-sector business cycle models. Equation (11) relates the marginal rate of substitution between expenditures to the relevant relative price. A conventional Euler equation, (12), where the real interest rate is expressed in units of $X_{1,t}$, governs the accumulation of financial assets. Finally, the trade-off between consumption expenditures and leisure is solved by equating the corresponding marginal rate of substitution to the opportunity cost of leisure i.e., the real wage, expressed in units of $X_{1,t}$.

The last two equations, (14) and (15), are specific to time use models and state that, due to substitutability between expenditures and time, the time intensity of consumption activities is inversely related to the cost of time i.e., the wage relative to the price of the relevant expenditure input. In other words, as the return from market work increases, the households substitute time for real expenditures in consumption, to an extent that depends on elasticities $(1/(1-b_1))$ and $(1/(1-b_2))$. Most of the housework models studied so far emphasize the role played by such substitution for aggregate consumption expenditures. Equations (14) and (15) extend this mechanism to its composition.

3.2. Firms

In the economy, there are two sectors indexed by j, each populated by infinitely many monopolistically competitive firms indexed by $i \in [0,1]$. Each firm buys hours worked on perfectly competitive markets in order to produce a variety i according to the linear production functions:

$$X_{j,t}(i) = Z_{j,t} h_{m,j,t}(i), \quad j \in \{1,2\}. \tag{16}$$

where $Z_{j,t}$ denotes labor productivity in sector j, following an AR(1) process with persistence ρ_{z_j}. Labor is homogeneous and perfectly mobile across firms and sectors. We follow Calvo (1983) and we assume that in any given period each firm resets its price $P_{j,t}(i)$ with a constant probability $(1-\theta_j)$. At a given price $P_{j,t}(i)$, production has to satisfy demand:

$$X_{j,t}(i) = \left[\frac{P_{j,t}(i)}{P_{j,t}}\right]^{-\varepsilon_j} X_{j,t}, \quad \varepsilon_j > 1, \tag{17}$$

where aggregate demand, $X_{j,t}$, is taken as given. We further assume that production is subsidized by the government, which pays a fraction τ_j of the unit cost of production. The real marginal cost, $RMC_{j,t}$, is constant across firms because of constant returns to scale in production and perfect competition on factor markets and, by cost minimization, it trivially satisfies

$$RMC_{j,t} = \frac{W_t h_{m,j,t}(i)}{P_{j,t} Z_{j,t}(i)}. \tag{18}$$

Hence, the discounted sum of current and future profits of a firm that resets its price reads as

$$\mathbb{E}_t \left\{ \sum_{s=0}^{\infty} \theta_j^s Q_{t,t+s} \left[P_{j,t}(i) X_{j,t+s}(i) - P_{j,t+s}(1-\tau_j) RMC_{j,t+s} X_{j,t+s}(i) \right] \right\}, \tag{19}$$

where $Q_{t,t+s}$ denotes the stochastic discount factor in period t for nominal profits s periods ahead

$$Q_{t,t+s} = \beta^s \mathbb{E}_t \left\{ \frac{\lambda_{j,t+s}}{\lambda_{j,t}} \Pi_{j,t,t+s}^{-1} \right\}, \quad \Pi_{j,t,t+s} \equiv \frac{P_{j,t+s}}{P_{j,t}}. \tag{20}$$

3.3. Policy and Market Clearing

We assume that the monetary authority sets the nominal interest rate, i_t, by following a Taylor-type rule that targets a weighted average of inflation in the two sectors:

$$(1+i_t) = (1+i) \left[\left(\frac{\Pi_{1,t}}{\Pi_1} \right)^{\gamma_{\pi_1}} \left(\frac{\Pi_{2,t}}{\Pi_2} \right)^{1-\gamma_{\pi_1}} \right]^{\gamma_\pi} M_t. \tag{21}$$

The weight on stabilizing inflation in sector one is γ_{π_1}, while γ_π determines the monetary authority's response to overall inflationary pressures. The steady-state value of a variable x_t is denoted by x, and M_t follows an AR(1) process with persistence ρ_M, representing a monetary policy shock. The clearing of all markets imply

$$\frac{X_{1,t}}{\Delta_{1,t} Z_{1,t}} + \frac{X_{2,t}}{\Delta_{2,t} Z_{2,t}} = h_{m,t}, \tag{22}$$

where $\Delta_{j,t}$ denotes relative price dispersion

$$\Delta_{j,t} \equiv \int_0^1 \left(\frac{P_{j,t}(i)}{P_{j,t}} \right)^{-\varepsilon_j} di. \tag{23}$$

3.4. Cyclicality of Time and Expenditures after Monetary Policy Shocks

The data show that consumption activities with more cyclical time inputs also tend to have more cyclical real expenditures, both unconditionally and after monetary policy shocks. This relationship is weaker for activities with low time intensity, suggesting that the expenditure implications of time–expenditure substitutability are strongest when household time is an important input in consumption. We interpret this evidence as pointing to two forces. First, higher substitutability between time and expenditure inputs amplifies the response of real expenditures when the opportunity cost of time changes. Second, low time intensity dampens this channel, since expenditure inputs account for a larger share of activity production even in steady state.

The model captures these forces through two sets of parameters. The parameters b_1 and b_2 govern the elasticity of substitution between real expenditures and time in activities 1 and 2, respectively. The parameters α_1 and α_2 govern the relative importance of expenditure inputs in each activity. We use the model to compute equilibrium responses to a contractionary monetary policy shock under alternative calibrations of these parameters.

Figure 4 reports impulse responses under unitary substitution across activities, $(1-b)^{-1} = 1$, and unitary time intensity. Circle-marker lines show the symmetric case in which the elasticity of substitution between expenditure and time inputs is one in both activities, $(1-b_1)^{-1} = (1-b_2)^{-1} = 1$. Star-marker lines instead raise substitutability in activity 2 to $(1-b_2)^{-1} = 2.5$. The model dynamics illustrate the mechanism previously described. After a contractionary monetary policy shock, market hours fall and time is reallocated toward consumption activities. When both activities have the same elasticity, time inputs and expenditures respond symmetrically across activities. When activity 2 has a higher elasticity

of substitution, the reallocation is stronger: foregone market hours are absorbed disproportionately by activity 2, while its expenditure input contracts more sharply. Thus, for a given time intensity, greater time–expenditure substitutability amplifies both the increase in time use and the decline in expenditures.

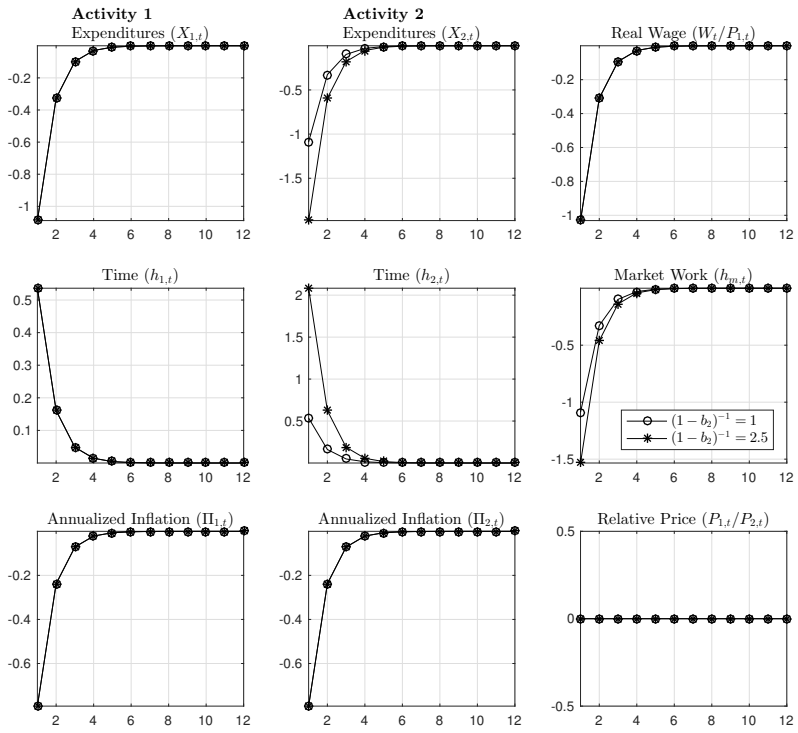


Figure 4: Impulse responses to a 100 basis-point contractionary monetary policy shock. Circled lines represent the case with unitary elasticity of substitution across activities ($(1-b)^{-1}=1$) and between expenditures and time within each activity ($(1-b_1)^{-1}=(1-b_2)^{-1}=1$). The starred line corresponds to the scenario where the elasticity between expenditures and time in activity two is increased to $(1-b_2)^{-1}=2.5$. All variables are expressed as percentage deviations from the steady state, except for inflation rates, which show annualized percentage-point deviations.

The data also show, however, that this positive association is not mechanical: some activities with highly cyclical time inputs display relatively muted expenditure responses. The model rationalizes this pattern through heterogeneity in time intensity. While Figure 4 shows that higher time–expenditure substitutability strengthens the comovement between time and expenditure inputs, Figure 5 shows that differences in time intensity can weaken, and potentially overturn, this relation. The figure compares two activities with the same elasticity of substitution between expenditure and time inputs but different time intensities. Following a contractionary monetary policy shock, lower time intensity in activity 2 dampens the contraction in its expenditure input, even as time is reallocated more strongly toward

that activity. Thus, for a given elasticity of substitution, low time intensity can generate highly cyclical time input together with a muted expenditure response, matching the pattern observed for some activities in the data.

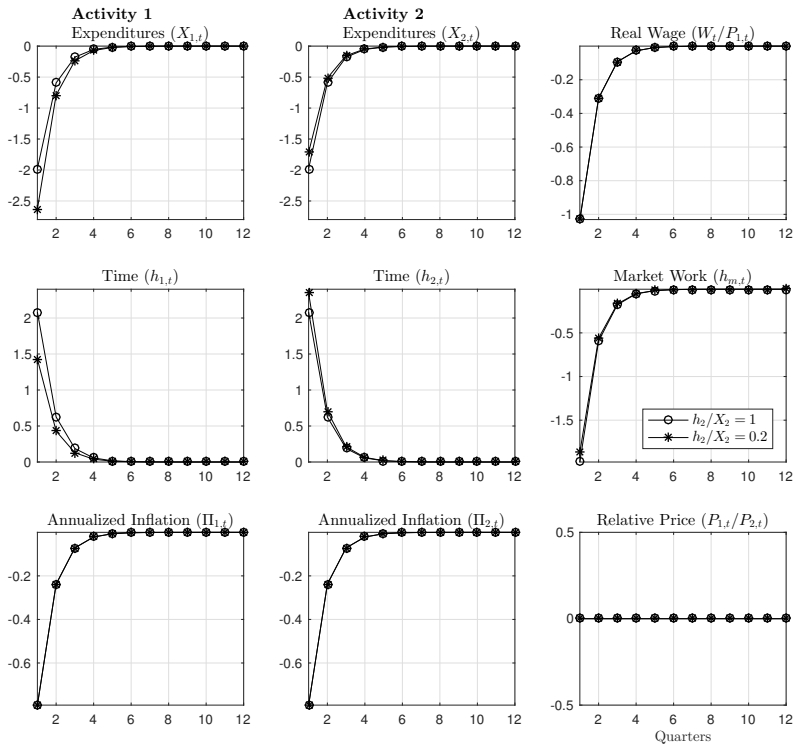


Figure 5: Impulse responses to a 100 basis-point contractionary monetary policy shock. Circled lines represent the case with unitary elasticity of substitution across activities ($(1-b)^{-1} = 1$), symmetric elasticity between expenditures and time within each activity ($(1-b_1)^{-1} = (1-b_2)^{-1} = 2.5$), and unitary time intensity for both activities ($h_1/X_1 = h_2/X_2 = 1$). The starred line corresponds to the scenario where time intensity of activity two is decreased to $h_2/X_2 = 0.2$. All variables are expressed as percentage deviations from the steady state, except for inflation rates, which show annualized percentage-point deviations.

In conclusion, the simplified two-sector model helps rationalize the key empirical findings from the previous section. Holding either margin fixed, expenditure cyclicality increases with both the elasticity of substitution between expenditure and time inputs and the time intensity of the activity. The model also explains why the empirical association is imperfect: activities with highly cyclical time inputs need not display highly cyclical expenditures when time intensity is low. Before turning to the quantitative analysis, we return to the data to estimate the elasticity parameters that govern substitution between time and expenditures.

4. The Quantitative Importance of Time–Expenditure Substitution

The two-sector model highlights the role of time–expenditure substitutability in shaping the joint cyclicality of time and expenditure inputs, consistent with our empirical evidence. We now assess the quantitative importance of this mechanism by calibrating the model to the data and comparing its predicted expenditure responses to monetary policy shocks with the impulse responses estimated in Section 2.

Specifically, we calibrate α, α_1, α_2, Z_1, and Z_2 to match steady-state average market hours, activity-level time inputs and time intensities, and the relative price of expenditure inputs across activities with the sample averages in our data.[18] We then use microeconomic data to estimate the elasticity of substitution between time and expenditure inputs, as well as the frequency of price adjustment for the bundles of goods and services that enter consumption activities as inputs.

4.1. Estimating Time–Expenditure Substitutability

We combine two complementary datasets for 2003–2019 to estimate the substitutability between household time and market expenditures across consumption activities. The CEX provides detailed spending patterns but no information on time use, while the ATUS records time allocation but no expenditures. The CEX is collected at the household level and the ATUS at the individual level, so we express CEX consumption and income in per-capita terms and use household-head characteristics to predict activity-level time use. We proceed in two steps. First, we build the combined dataset by imputing activity-level time use from the ATUS into CEX households, and we validate the imputed data through out-of-sample forecasting exercises. Second, we estimate the elasticity of substitution between time and expenditure inputs for each activity and compare the estimated elasticities across activities.

We combine CEX and ATUS following the iterative group-mean imputation procedure of Boerma and Karabarbounis (2021). Each CEX household is assigned the average activity-level time input of ATUS respondents using demographic characteristics observed in both surveys. Matching begins with basic demographics—work status, race, gender, and age—and iteratively incorporates additional characteristics when cell sizes permit. In our representative-agent model, this conditional mean is the data counterpart of activity-level time input, so group-mean imputation is directly aligned with the object we seek to measure.[19]

[18] See Appendix F for details.

[19] Because our analysis considers a relatively disaggregated set of activities, many cells contain a large

We assess imputation quality using out-of-sample forecasting exercises. Specifically, we split ATUS into training (70%) and test (30%) samples, estimate the imputation model on the training sample, and compare predicted and realized time allocations in the test sample. Table 4 reports observed and predicted weekly hours across activities. The group mean procedure closely reproduces observed time-use patterns across all activities. Appendix Figure G.4 further shows that the imputed series closely track the year-to-year movements in actual ATUS time use across activities and consumption bundles.

Activity	Actual hours (1)	Predicted hours (2)
Cooking, Cleaning, Eating, Drinking	17.11	17.23
TV, Radio, Music	16.96	16.62
Socializing, Relaxing and Hobbies	10.73	10.75
Personal Care	5.31	5.31
Home Maintenance and Gardening	2.57	2.48
Sports and Exercise	1.96	2.00
Household Management	1.68	1.72
Animals and Pets	0.92	0.94
Entertainment	0.78	0.76
Travel (as a form of entertainment)	0.33	0.33

Table 4: Actual average weekly hours from the ATUS test sample (Column 1) and predicted average weekly hours with group mean imputation (Column 2).

We next estimate the elasticity of expenditure-to-time ratios with respect to wages, where time inputs are imputed conditional on observables. Interpreted through our representative-agent model, this elasticity provides the empirical counterpart of the intratemporal substitution parameter governing the allocation between expenditure and time inputs. Following Aguiar and Bils (2015), we specify our estimating equation in log deviations from activity-level sample means:

$$\log\left(\frac{\hat{X}_{i,j,t}}{\hat{\tau}_{i,j,t}}\right) = \alpha_j + \eta_j \log w_{i,j,t} + \Gamma_j Z_{i,t} + \delta_{j,t} + u_{i,j,t},$$

where $\hat{X}_{i,j,t}$ and $\hat{\tau}_{i,j,t}$ denote, respectively, expenditure and imputed time inputs for activity j expressed in deviations from their sample means across households. The vector $Z_{i,t}$

number of zero observations. These zeros reflect legitimate extensive-margin choices that belong to the relevant conditional mean. Since the model does not separately distinguish extensive and intensive margins, we do not need to model participation decisions separately to compare the model to the data. We nevertheless assess the robustness of our procedure by comparing it with Tobit and Heckman-type imputations, following Folbre et al. (2024) and Mukoyama et al. (2018).

includes demographic characteristics common to both datasets: work status, gender, race, age, number of children, and marital status. The term $\delta_{j,t}$ denotes year fixed effects in the regression for activity j. The household-level activity-specific real wage is defined as

$$w_{i,j,t} \equiv \frac{W_{i,t}}{P_{j,t}},$$

where $W_{i,t}$ is the nominal wage and $P_{j,t}$ is the price index for activity j. Identification comes from wage variation orthogonal to observables Z. Intuitively, we compare households with similar predicted time-use profiles but different effective opportunity costs of time. Under the maintained model restriction, residual wage variation traces the same intratemporal allocation margin that operates within the representative-agent framework.

Because wage rates may be measured with error and may respond endogenously to labor supply decisions, we instrument wages using educational attainment and total consumption expenditures. Standard errors are computed using bootstrap procedures that re-estimate both the imputation and elasticity estimation stages and combine estimates across imputations using the multiple-imputation procedure of Rubin (1987).

Table 5 reports our main estimates. The results show that substitutability between expenditure and time inputs varies substantially across activities and is generally higher among activities with more cyclical time inputs. For instance, Home Maintenance and Gardening ($\varepsilon = 0.53$) displays an elasticity of 3.42, while Cooking, Cleaning, Eating, and Drinking ($\varepsilon = 0.23$) displays an elasticity of 1.41.[20]

Grouping activities by time cyclicality yields similar conclusions. The estimated elasticity for the high-cyclicality bundle is 3.13, compared with 1.62 for the low-cyclicality bundle. We use these estimates as activity-level calibration targets for the intratemporal substitution parameters in the model.

4.2. Price Stickiness across Bundles

Based on confidential CPI microdata for the period 1978–2019, Montag and Villar Vallenas (2025) estimate price duration at the level of Entry Level Items (ELIs), the most granular product categories in the publicly identifiable CPI classification. Each ELI corresponds to a narrowly defined category of household purchases such as men's shirts, fresh whole milk, household paper products, or airline fares. We map each ELI to one of our ten consumption activities and aggregate ELI-level price durations to the activity level, using CPI expenditure weights throughout. Then we further aggregate price duration for the high and

[20]Results are robust to alternative imputation methods reported in Appendix G.

Activity	Time Cyclicality ε^j (1)	Elasticity of Substitution $(1-b_j)^{-1}$ (2)
Travel (as a form of entertainment)	0.48	3.47 (0.07)
Home Maintenance and Gardening	0.53	3.42 (0.05)
Household Management	0.43	3.40 (0.07)
Sports and Exercise	0.52	3.08 (0.06)
Personal Care	-0.07	2.51 (0.02)
Entertainment	0.53	2.35 (0.06)
Animals and Pets	0.28	2.00 (0.04)
Socializing, Relaxing and Hobbies	0.39	1.81 (0.02)
TV, Radio, Music	0.35	1.52 (0.01)
Cooking, Cleaning, Eating, Drinking	0.23	1.41 (0.01)

Table 5: Elasticity of Substitution across Consumption Activities. Column (1) reports time cyclicality for each activity (see Table 3). Column (2) reports estimated elasticities of substitution using group mean imputation with total consumption expenditures and educational attainment as instruments. Standard errors are reported in parentheses.

low time-cyclicality bundles as defined in the empirical analysis (Section 2.5). We focus on regular price durations (excluding sales) and report bundle-level statistics based on the weighted median across ELIs. Price duration translates directly into a quarterly Calvo parameter, with longer durations corresponding to higher (more sticky) values. Details of the mapping procedure and robustness to alternative samples—including Montag and Villar Vallenas (2025)'s extension through 2024 and the estimates of Nakamura and Steinsson (2008) for 1998–2005—are reported in Appendix H.

Figure 6 shows that price stickiness is similar across the high and low time-cyclicality bundles. The black bars, which use the full consumption bundle, imply Calvo parameters of 0.59 and 0.63, respectively, both close to the aggregate benchmark of 0.60 across all ELIs. The difference is small, corresponding to less than one month in implied price duration (7.4 versus 8.2 months). The gray bars restrict the calculation to activity-specific expenditure inputs and widen the gap modestly, with implied Calvo parameters of 0.59 and 0.70.

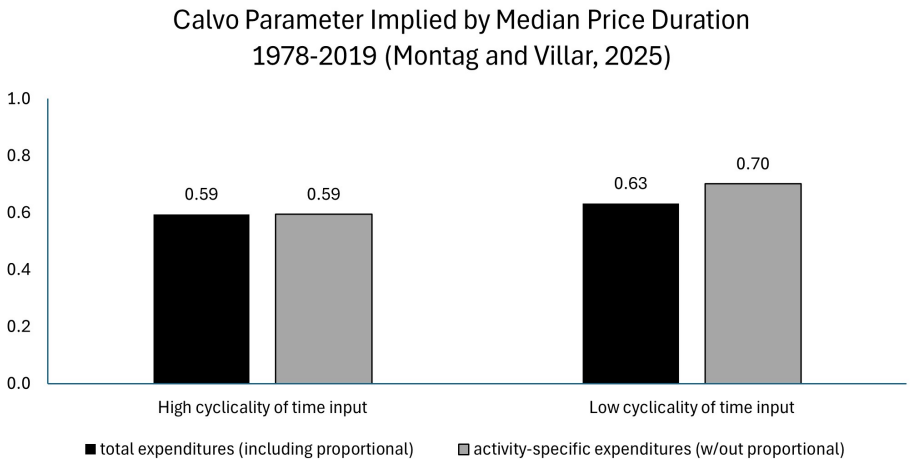


Figure 6: Bundle-level price stickiness. Implied quarterly Calvo parameters for high and low time-cyclicality bundles, based on weighted median regular price durations from Montag and Villar Vallenas (2025) for 1978–2019. Black bars use the full consumption bundle, combining activity-specific and proportional expenditures. Gray bars use activity-specific expenditure inputs only.

4.3. Quantitative Implications of Time–Expenditure Substitutability

We calibrate the model at the level of the two bundles used in the empirical analysis: the low time-cyclicality bundle, indexed by $j = 1$, and the high time-cyclicality bundle, indexed by $j = 2$. The calibration relies on two sets of empirical moments. The first pins down the model's steady state: average market hours, bundle-level time inputs, time intensities, and relative prices of expenditure inputs. The second disciplines parameters that govern dynamics: the time–expenditure elasticity of substitution within each bundle and the frequency of price adjustment for the corresponding expenditure inputs.

The first set of moments is constructed from ATUS time-use data, activity-level real expenditures, and activity-level prices. Consistent with the empirical construction of the activity bundles, the baseline calibration normalizes the time endowment over market work and consumption activities, excluding leisure from the relevant time aggregate. Market work accounts for 33 percent of this endowment, while time allocated to the low and high time-cyclicality bundles accounts for 58 and 9 percent, respectively. We combine these time inputs with activity-level real expenditures to measure bundle-level time intensities, and use activity-level Fisher price indices to measure relative prices against the aggregate PCE deflator. The parameters α, α_1, α_2, Z_1, and Z_2 are chosen so that the model steady state matches these sample averages. Table 6 reports the resulting parameter values and the targets used to discipline them.

We calibrate the remaining targets using the estimates of substitution and price adjustment from the previous subsections. The estimated time–expenditure elasticities from

Section 4.1 pin down the curvature parameters within each bundle: $b_1 = 0.38$ for the low time-cyclicality bundle and $b_2 = 0.68$ for the high time-cyclicality bundle. We set $b = 0$, corresponding to Cobb–Douglas aggregation across activities. The frequency of price adjustment estimated in Section 4.2 maps directly into the Calvo parameters, $\theta_1 = 0.63$ and $\theta_2 = 0.59$, respectively. Importantly, estimated nominal rigidities differ little across bundles, while estimated substitution elasticities differ substantially. The quantitative exercise therefore isolates the role of time–expenditure substitutability from that of price stickiness.

Mnemonic	Value	Target/Source
α	0.84	Average market hours
α_1	0.12	Time input and time intensity, low-cyclicality bundle
α_2	0.04	Time input and time intensity, high-cyclicality bundle
Z_1	51.81	Relative price, low-cyclicality bundle
Z_2	51.78	Relative price, high-cyclicality bundle
b	0.00	Cobb–Douglas aggregation across activities
b_1	0.38	$(1 - b_1)^{-1} = 1.62$
b_2	0.68	$(1 - b_2)^{-1} = 3.10$
θ_1	0.63	Price duration, low-cyclicality bundle
θ_2	0.59	Price duration, high-cyclicality bundle

Table 6: Quantitative calibration.

Figure 7 reports the model-implied responses of expenditures and time inputs to a contractionary monetary policy shock. Qualitatively, the model reproduces the key pattern observed in the data: on impact, relative expenditures decline more for the high time-cyclicality bundle than for the low time-cyclicality bundle. To illustrate the role of time-expenditure substitutability in generating this asymmetry, we display two cases, one for the baseline calibration reported in Table 6 (circle-marker lines) and for the case where the elasticity of substitution of the high-cyclicality bundle is raised to 5 (star-marker lines). In the latter case, which assumes implausibly large elasticity between time and expenditures, we can match almost exactly the empirical responses to a monetary policy shock on impact. Under the baseline calibration, which uses elasticities estimated from the micro data, the model accounts for roughly forty percent of the impact responses. The remaining gap can naturally reflect additional demand-composition channels emphasized in the literature, including non-homothetic shifts between necessities and luxuries (Orchard, 2022) and essential-versus-discretionary expenditure channels with household heterogeneity (Andreolli et al., 2024).

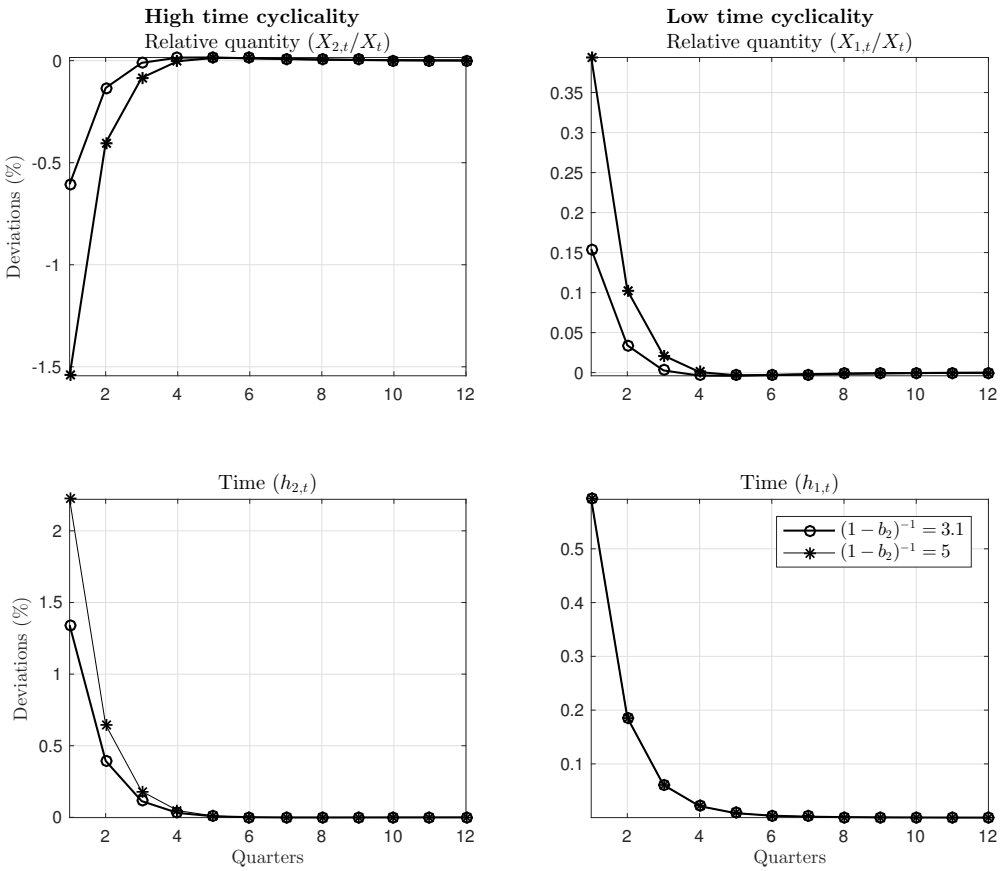


Figure 7: Model-implied responses to a contractionary monetary policy shock. Circle-marker lines report the baseline calibration using the estimated elasticities of substitution from Section 4.1. Star-marker lines report the alternative calibration with elasticity of substitution equal to 5 for the high time-cyclicality bundle. Variables are expressed as percent deviations from steady state.

The model is less successful in matching the persistence of the empirical responses. This is not surprising given the stylized environment and the absence of endogenous state variables or additional propagation mechanisms. In particular, the model abstracts from channels such as habit formation, durable expenditures, and adjustment frictions that may contribute to the persistence of expenditure dynamics following monetary policy shocks.

5. Conclusions

This paper documents new facts about the joint cyclicality of consumption expenditures and household time. Activities toward which households reallocate more time when market work falls also tend to experience larger relative expenditure contractions, with the strength of this relationship shaped by time intensity and time–expenditure substitutability. A New

Keynesian model with time use rationalizes these patterns and shows that the estimated substitution channel accounts for a sizable share of heterogeneous expenditure responses to monetary policy shocks.

More broadly, the framework points to two extensions. First, because consumption activities combine market expenditures with household time, the welfare-relevant cost of consumption depends on both goods prices and the opportunity cost of time.[21] A full cost-of-living analysis, in the spirit of exact price-index approaches such as Feenstra (1994) and Redding and Weinstein (2020), would derive and implement the corresponding time-use-adjusted price index. Second, the same mechanism raises a distinct optimal-policy question: if households can substitute time for market expenditures, the welfare costs of sectoral price stickiness and relative-price misalignment may depend not only on expenditure shares and nominal rigidities, but also on time intensity and time–expenditure substitutability.

[21] The formal derivation is provided in Appendix E.

References

Afrouzi, Hassan, Saroj Bhattarai, and Edson Wu, "Relative-price changes as aggregate supply shocks revisited: Theory and evidence," *Journal of Monetary Economics*, 2024, *148*, 103650.

Aguiar, Mark and Mark Bils, "Has consumption inequality mirrored income inequality?," *American Economic Review*, 2015, *105* (9), 2725–2756.

_ , Erik Hurst, and Loukas Karabarbounis, "Time Use During the Great Recession," *American Economic Review*, 8 2013, *103*, 1664–1696.

Andreolli, Michele, Natalie Rickard, and Paolo Surico, "Non-Essential Business-Cycles," 2024.

Aoki, Kosuke, "Optimal monetary policy responses to relative-price changes," *Journal of monetary economics*, 2001, *48* (1), 55–80.

Aruoba, Borağan and Thomas Drechsel, "The long and variable lags of monetary policy: Evidence from disaggregated price indices," *Journal of Monetary Economics*, 2024, *148*, 103635.

Bauer, Michael and Eric Swanson, "An alternative explanation for the "fed information effect"," *American Economic Review*, 2023, *113* (3), 664–700.

Becker, Gary, "A Theory of the Allocation of Time," *The economic journal*, 1965, *75* (299), 493–517.

Benhabib, Jess, Richard Rogerson, and Randall Wright, "Homework in Macroeconomics: Household Production and Aggregate Fluctuations," *Journal of Political Economy*, 1991, *99* (6), 1166–1187.

Benigno, Pierpaolo, "Optimal monetary policy in a currency area," *Journal of international economics*, 2004, *63* (2), 293–320.

Boerma, Job and Loukas Karabarbounis, "Inferring inequality with home production," *Econometrica*, 2021, *89* (5), 2517–2556.

Boivin, Jean, Marc P Giannoni, and Ilian Mihov, "Sticky prices and monetary policy: Evidence from disaggregated US data," *American Economic Review*, 2009, *99* (1), 350–384.

Bouakez, Hafedh, Emanuela Cardia, and Francisco Ruge-Murcia, "The transmission of monetary policy in a multisector economy," *International Economic Review*, 2009, *50* (4), 1243–1266.

Cacciatore, Matteo, Stefano Gnocchi, and Daniela Hauser, "Time use and macroeconomic uncertainty," *Review of Economics and Statistics*, 2024, pp. 1–36.

Calvo, Guillermo, "Staggered Prices in a Utility Maximizing Framework," *Journal of Monetary Economics*, 1983, *12* (3), 383–398.

Christiano, Lawrence and Terry Fitzgerald, "The band pass filter," *International Economic Review*, 2003, *44* (2), 435–465.

Feenstra, Robert C., "New Product Varieties and the Measurement of International Prices," *American Economic Review*, 1994, *84* (1), 157–177.

Folbre, Nancy, Thomas Masterson, Fernando Rios-Avila, and Ajit Zacharias, "Integrating Nonmarket Consumption into the Bureau of Labor Statistics Consumer Expenditure Survey," *Bureau of Labor Statistics*, 2024.

Galí, Jordi, *Monetary policy, inflation and the business cycle*, Princeton Univerisity Press, 2008.

Gertler, Mark and Peter Karadi, "Monetary Policy Surprises, Credit Costs, and Economic Activity," *American Economic Journal: Macroeconomics*, 2015, *7* (1), 44–76.

Gilchrist, Simon and Egon Zakrajšek, "Credit spreads and business cycle fluctuations," *American economic review*, 2012, *102* (4), 1692–1720.

Gnocchi, Stefano, Daniela Hauser, and Evi Pappa, "Housework and Fiscal Expansions," *Journal of Monetary Economics*, 2016, *79*, 94–108.

Gomme, Paul, Finn E Kydland, and Peter Rupert, "Home production meets time to build," *Journal of Political Economy*, 2001, *109* (5), 1115–1131.

Gronau, Reuben and Daniel Hamermesh, "Time vs. goods: The value of measuring household production technologies," *Review of Income and Wealth*, 2006, *52* (1), 1–16.

Jarociński, Marek and Peter Karadi, "Deconstructing monetary policy surprises—the role of information shocks," *American Economic Journal: Macroeconomics*, 2020, *12* (2), 1–43.

Kydland, Finn E and Edward C Prescott, "Time to build and aggregate fluctuations," *Econometrica: Journal of the Econometric Society*, 1982, pp. 1345–1370.

Long, John and Charles Plosser, "Real business cycles," *Journal of political Economy*, 1983, *91* (1), 39–69.

Maćkowiak, Bartosz, Emanuel Moench, and Mirko Wiederholt, "Sectoral price data and models of price setting," *Journal of Monetary Economics*, 2009, *56*, S78–S99.

Mertens, Karel and Morten Ravn, "The Dynamic Effects of Personal and Corporate Income Tax Changes in the United States," *American Economic Review*, 2013, *103* (4), 1212–1247.

Miranda-Agrippino, Silvia and Giovanni Ricco, "The Transmission of Monetary Policy Shocks," *American Economic Journal: Macroeconomics*, 2021, *13* (3), 74–107.

Montag, Hugh and Daniel Villar Vallenas, "Post-Pandemic Price Flexibility in the US: Evidence and Implications for Price Setting Models," 2025.

Mukoyama, Toshihiko, Christina Patterson, and Ayşegül Şahin, "Job search behavior over the business cycle," *American Economic Journal: Macroeconomics*, 2018, *10* (1), 190–215.

Nakamura, Emi and Jón Steinsson, "Five facts about prices: A reevaluation of menu cost models," *The Quarterly Journal of Economics*, 2008, *123* (4), 1415–1464.

Orchard, Jacob, "Cyclical demand shifts and cost of living inequality," *Available at SSRN 4033572*, 2022.

Redding, Stephen J. and David E. Weinstein, "Measuring Aggregate Price Indices with Taste Shocks: Theory and Evidence for CES Preferences," *Quarterly Journal of Economics*, 2020, *135* (1), 503–560.

Rubin, Donald B., *Multiple Imputation for Nonresponse in Surveys*, New York: Wiley, 1987.

Ruge-Murcia, Francisco and Alexander Wolman, "Relative Price Shocks and Inflation," 2022.

Stock, James and Mark Watson, "Identification and estimation of dynamic causal effects in macroeconomics using external instruments," *The Economic Journal*, 2018, *128* (610), 917–948.

Wolman, Alexander, "The optimal rate of inflation with trending relative prices," *Journal of money, credit and banking*, 2011, *43* (2-3), 355–384.

Woodford, Michael, *Interest and Prices: Foundations of a Theory of Monetary Policy*, Princeton University Press, 2003.

Appendix A. Defining Activities Using Time Use and Real Consumption Expenditures

The table below outlines the definition of each activity, including its time and consumption expenditure inputs. Time use codes are based on the 2019 ATUS Lexicon, and ATUS sample restrictions follow Cacciatore et al. (2024), limiting the sample to respondents aged 18–65 who completed the survey.

A small subset of ATUS codes captures time spent across multiple activities rather than a single one. Specifically:

- **Shopping gas**: 07-01-02 Purchasing Gas; 18-07-02 Travel related to Purchasing Gas; Total time for 'Shopping gas' is allocated in equal parts to all activities involving travel time (i.e., all activities defined below with the exception of 'TV, Radio and Music', and 'Sleeping').

- **Consumer purchases**: 07-01-02 Purchasing Gas; 18-07-02 Travel related to Purchasing Gas; 07-01-04 Other Shopping (not groceries, food, and gas); 18-07-04 Travel related to Other Shopping (not groceries, food, gas); 07-01-05 Waiting associated with Shopping; 07-01-99 Other Shopping Activities; 07-02 Researching Purchases; 07-03 Security Procedures related to Purchases; 07-99 Consumer Purchases - Other Activities; 07-07-99 Other Consumer Purchases; 18-07-99 Travel related to Other Consumer Purchases; 16-01-04 Telephone Calls with Salespeople; Total time for 'Consumer purchases' is allocated in equal part to all activities involving goods and services (i.e., all activities defined below with the exception of 'Market Work and Related Activities', and 'Sleeping').

These multi-activity time inputs are negligible. Between 2003 and 2019, 'Shopping for gas' accounts for an average of 0.36 hours per week, and 'Consumer purchases' account for 2.39 hours per week. In total, these inputs represent an average of 2.75 hours per week, or 1.6% of total weekly hours.

Similarly, some consumption items cannot be allocated to a single activity but relate to multiple activities (e.g., vehicle expenditures, gas, clothing, etc.):

1. We allocate consumption expenditures to selected activities based on their relative time intensity (using average weekly hours from 2003–2019). For details on how expenditures are proportionately allocated, see the table below.
2. Following the literature, we assume that sleep and market work are activities that rely exclusively on time (see e.g., Gronau and Hamermesh, 2006).

Activity	ATUS Codes	NIPA Consumption Expenditures
Cooking, Cleaning, Eating, Drinking	02-01 Housework 18-02-01 Travel related to housework 02-02 Food and Drink preparation and cleanup 18-02-02 Travel related to Food and Drink preparation and cleanup 07-01-01 Grocery Shopping 18-07-01 Travel related to Grocery Shopping 07-01-03 Purchasing Food (not groceries) 18-07-03 Travel related to Purchasing Food (not groceries) 09-01 Household Services 18-09-01 Travel related to Household Services 09-99 Other Household Services 18-09-99 Travel related to Other Household Services 11 Eating and Drinking 18-11 Travel related to Eating and Drinking **Proportional Time Use**: 07-01-02 Purchasing Gas 18-07-02 Travel related to Purchasing Gas 07-01-04 Other Shopping (not groceries, food, and gas) 18-07-04 Travel related to Other Shopping (not groceries, food, gas) 07-01-05 Waiting associated with Shopping 07-01-99 Other Shopping Activities 07-02 Researching Purchases 07-03 Security Procedures related to Purchases 07-99 Consumer Purchases - Other Activities 07-07-99 Other Consumer Purchases 18-07-99 Travel related to Other Consumer Purchases 16-01-04 Telephone Calls with Salespeople	Household appliances (L3, 27) Glassware, tableware, household utensils (L3, 30) Food, nonalcoholic beverages (off-premises consumption) (L3, 72) Alcoholic beverages (off-premises consumption) (L3, 97) Household supplies (L3, 129) Food services (L3, 233) Clothing and footwear services (L4, 309) Domestic services (L4, 326) **Proportional Consumption Expenditures**: New motor vehicles (L3, 5) Net purchases of used motor vehicles (L3, 10) Motor vehicle parts and accessories (L3, 18) Gasoline and other energy goods (L2, 111) Other motor vehicle services (L4, 191) Public transportation (L3, 197) Furniture and furnishings (L3, 22) Housing and utilities (L2, 150) Information processing equipment (L4, 46) Jewelry and watches (L3, 61) Telephone and communication equipment (L3, 69) Clothing and footwear (L2, 102) Telecommunication services (L4, 280) Postal and delivery services (L4, 284) Internet access (L4, 287)

Home Maintenance and Gardening	02-03 Interior Maintenance 18-02-03 Travel related to Interior Maintenance 02-04 Exterior Maintenance 18-02-04 Travel related to Exterior Maintenance 02-05 Lawn, Garden, Houseplants 18-02-05 Travel related to Lawn, Garden, Houseplants 02-07 Vehicle Care, Maintenance 18-02-07 Travel related to Vehicle Care, Maintenance 02-08 Appliances, Tools, Toys 18-02-08 Travel related to Appliances, Tools, Toys 09-02 Home Maintenance Services 18-09-02 Travel related to Home Maintenance Services 09-04 Lawn and Garden Services 18-09-04 Travel related to Lawn and Garden Services 09-05 Vehicle Maintenance, Repair Services 18-09-05 Travel related to Vehicle Maintenance, Repair Services 16-01-06 Telephone Calls with Service Providers **Proportional Time Use**: 07-01-02 Purchasing Gas 18-07-02 Travel related to Purchasing Gas 07-01-04 Other Shopping (not groceries, food, and gas) 18-07-04 Travel related to Other Shopping (not groceries, food, gas) 07-01-05 Waiting associated with Shopping 07-01-99 Other Shopping Activities 07-02 Researching Purchases 07-03 Security Procedures related to Purchases 07-99 Consumer Purchases - Other Activities 07-07-99 Other Consumer Purchases 18-07-99 Travel related to Other Consumer Purchases 16-01-04 Telephone Calls with Salespeople	Tools and equipment for house and garden (L3, 33) Flowers, seeds, and potted plants (L4, 127) Motor vehicle maintenance and repair (L4, 190) Moving, storage, and freight services (L4, 327) Repair of furniture, furnishings, floors (L4, 328) Repair of household appliances (L4, 329) Other household services (L4, 330) **Proportional Consumption Expenditures**: New motor vehicles (L3, 5) Net purchases of used motor vehicles (L3, 10) Motor vehicle parts and accessories (L3, 18) Gasoline and other energy goods (L2, 111) Other motor vehicle services (L4, 191) Public transportation (L3, 197) Furniture and furnishings (L3, 22) Housing and utilities (L2, 150) Information processing equipment (L4, 46) Jewelry and watches (L3, 61) Telephone and communication equipment (L3, 69) Clothing and footwear (L2, 102) Telecommunication services (L4, 280) Postal and delivery services (L4, 284) Internet access (L4, 287)

Household Management	02-09 Household Management 18-02-09 Travel related to Household Management 08-02 Financial Services, Banking 18-08-02 Travel related to Financial Services, Banking 08-03 Legal Services 18-08-03 Travel related to Legal Services 08-06 Real Estate Services 18-08-06 Travel related to Real Estate Services 08-08 Security Procedures related to Prof. Services 10-01-03 Obtaining Licenses, Paying Fines/Fees/Taxes 18-10-01 Travel related to Government Services 16-01-05 Telephone Calls with Prof. Service Providers **Proportional Time Use**: 07-01-02 Purchasing Gas 18-07-02 Travel related to Purchasing Gas 07-01-04 Other Shopping (not groceries, food, and gas) 18-07-04 Travel related to Other Shopping (not groceries, food, gas) 07-01-05 Waiting associated with Shopping 07-01-99 Other Shopping Activities 07-02 Researching Purchases 07-03 Security Procedures related to Purchases 07-99 Consumer Purchases - Other Activities 07-07-99 Other Consumer Purchases 18-07-99 Travel related to Other Consumer Purchases 16-01-04 Telephone Calls with Salespeople	Professional and other services (L3, 296) **Proportional Consumption Expenditures**: New motor vehicles (L3, 5) Net purchases of used motor vehicles (L3, 10) Motor vehicle parts and accessories (L3, 18) Gasoline and other energy goods (L2, 111) Other motor vehicle services (L4, 191) Public transportation (L3, 197) Furniture and furnishings (L3, 22) Housing and utilities (L2, 150) Information processing equipment (L4, 46) Jewelry and watches (L3, 61) Telephone and communication equipment (L3, 69) Clothing and footwear (L2, 102) Telecommunication services (L4, 280) Postal and delivery services (L4, 284) Internet access (L4, 287)

TV, Radio and Music	12-03-03 Television and Movies (not religious) 12-03-04 Television (religious) 12-03-05 Listening to Radio 12-03-06 Listening to/Playing Music (not Radio) **Proportional Time Use**: 07-01-04 Other Shopping (not groceries, food, and gas) 18-07-04 Travel related to Other Shopping (not groceries, food, gas) 07-01-05 Waiting associated with Shopping 07-01-99 Other Shopping Activities 07-02 Researching Purchases 07-03 Security Procedures related to Purchases 07-99 Consumer Purchases - Other Activities 07-07-99 Other Consumer Purchases 18-07-99 Travel related to Other Consumer Purchases 16-01-04 Telephone Calls with Salespeople	Video and audio equipment (L4, 38) Musical instruments (L3, 59) Cable, satellite, other television services (L4, 217) Video and audio streaming and rental (L4, 221) **Proportional Consumption Expenditures**: Furniture and furnishings (L3, 22) Housing and utilities (L2, 150) Information processing equipment (L4, 46) Jewelry and watches (L3, 61) Telephone and communication equipment (L3, 69) Clothing and footwear (L2, 102) Telecommunication services (L4, 280) Postal and delivery services (L4, 284) Internet access (L4, 287)

Sports and Exercise	13-01 Participating in Sports/Exercise	Sporting equipment, supplies, guns (L3, 50)
	18-13-01 Travel related to Sports/Exercise	Sports and recreational vehicles (L3, 51)
	13-03-01 Waiting related to Sports/Exercise	Membership clubs, sports centers (L4, 209)
	13-03-99 Waiting associated to Sports/Exercise	Maintenance and repair of recreational vehicles and sports equipment (L4, 231)
	13-04-01 Security related to to Sports/Exercise	
	13-04-99 Other security related to Sports/Exercise	
	13-99 Other Sports, Exercise, Recreation	**Proportional Consumption Expenditures**:
	18-13-99 Travel related to Other Sports, Exercise, Recreation	New motor vehicles (L3, 5)
		Net purchases of used motor vehicles (L3, 10)
	Proportional Time Use:	Motor vehicle parts and accessories (L3, 18)
	07-01-02 Purchasing Gas	Gasoline and other energy goods (L2, 111)
	18-07-02 Travel related to Purchasing Gas	Other motor vehicle services (L4, 191)
	07-01-04 Other Shopping (not groceries, food, and gas)	Public transportation (L3, 197)
	18-07-04 Travel related to Other Shopping (not groceries, food, gas)	Furniture and furnishings (L3, 22)
	07-01-05 Waiting associated with Shopping	Housing and utilities (L2, 150)
	07-01-99 Other Shopping Activities	Information processing equipment (L4, 46)
	07-02 Researching Purchases	Jewelry and watches (L3, 61)
	07-03 Security Procedures related to Purchases	Telephone and communication equipment (L3, 69)
	07-99 Consumer Purchases - Other Activities	Clothing and footwear (L2, 102)
	07-07-99 Other Consumer Purchases	Telecommunication services (L4, 280)
	18-07-99 Travel related to Other Consumer Purchases	Postal and delivery services (L4, 284)
	16-01-04 Telephone Calls with Salespeople	Internet access (L4, 287)

Animals and Pets	02-06 Animals and Pets (including playing) 18-02-06 Travel related to Animals and Pets 08-07 Veterinary services 18-08-07 Travel related to using Veterinary services 09-03 Household services, Pet services 18-09-03 Travel related to using Pet Services **Proportional Time Use**: 07-01-02 Purchasing Gas 18-07-02 Travel related to Purchasing Gas 07-01-04 Other Shopping (not groceries, food, and gas) 18-07-04 Travel related to Other Shopping (not groceries, food, gas) 07-01-05 Waiting associated with Shopping 07-01-99 Other Shopping Activities 07-02 Researching Purchases 07-03 Security Procedures related to Purchases 07-99 Consumer Purchases - Other Activities 07-07-99 Other Consumer Purchases 18-07-99 Travel related to Other Consumer Purchases 16-01-04 Telephone Calls with Salespeople	Pets and related products (L4, 126) Veterinary and other services for pets (L4, 229) **Proportional Consumption Expenditures**: New motor vehicles (L3, 5) Net purchases of used motor vehicles (L3, 10) Motor vehicle parts and accessories (L3, 18) Gasoline and other energy goods (L2, 111) Other motor vehicle services (L4, 191) Public transportation (L3, 197) Furniture and furnishings (L3, 22) Housing and utilities (L2, 150) Information processing equipment (L4, 46) Jewelry and watches (L3, 61) Telephone and communication equipment (L3, 69) Clothing and footwear (L2, 102) Telecommunication services (L4, 280) Postal and delivery services (L4, 284) Internet access (L4, 287)

Personal Care	01-02 Personal Care Grooming	Personal care products (L3, 135)
	18-01 Travel related to Personal Care	Personal care services (L4, 306)
	01-04 Personal Care Activities	
	01-99 Other Personal Care	**Proportional Consumption Expenditures**:
	08-05 Personal Care Services	New motor vehicles (L3, 5)
	18-08-05 Travel related to Personal Care Services	Net purchases of used motor vehicles (L3, 10)
		Motor vehicle parts and accessories (L3, 18)
	Proportional Time Use:	Gasoline and other energy goods (L2, 111)
	07-01-02 Purchasing Gas	Other motor vehicle services (L4, 191)
	18-07-02 Travel related to Purchasing Gas	Public transportation (L3, 197)
	07-01-04 Other Shopping (not groceries, food, and gas)	Furniture and furnishings (L3, 22)
	18-07-04 Travel related to Other Shopping (not groceries, food, gas)	Housing and utilities (L2, 150)
	07-01-05 Waiting associated with Shopping	Information processing equipment (L4, 46)
	07-01-99 Other Shopping Activities	Jewelry and watches (L3, 61)
	07-02 Researching Purchases	Telephone and communication equipment (L3, 69)
	07-03 Security Procedures related to Purchases	Clothing and footwear (L2, 102)
	07-99 Consumer Purchases - Other Activities	Telecommunication services (L4, 280)
	07-07-99 Other Consumer Purchases	Postal and delivery services (L4, 284)
	18-07-99 Travel related to Other Consumer Purchases	Internet access (L4, 287)
	16-01-04 Telephone Calls with Salespeople	

Socializing, Relaxing, and Hobbies	08-99 Other Prof./Pers. Care Serv. 18-08-99 Travel related to Other Prof./Pers. Care Serv. 12-01 Socializing/Communicating 18-12-01 Travel related to Socializing/Communicating 12-02 Attending/Hosting Social Events 18-12-02 Travel related to Attending/Hosting Events 12-03-01 Relaxing, thinking; 12-03-02 Tobacco and drug use 12-03-07 Playing games; 12-03-08 Computer Use for Leisure 12-03-09 Arts and crafts; 12-03-10 Collecting; 12-03-11 Hobbies 12-03-12 Reading and 12-03-13 Writing 12-03-99 Other Relaxing and Leisure Activities 12-05 Associated Waiting 12-99 Other Socializing, Relaxing and Leisure Activities 16-01-01 Telephone Calls with Family Members 18-16 Travel related to Telephone Calls 16-01-02 and 16-01-99 Telephone Calls 16-02 Waiting Associated with Telephone Calls 16-99 Other Telephone Calls 18-12-03 Travel related to relaxing and leisure 18-12-99 Other travel related to socializing, relaxing **Proportional Time Use**: 07-01-02 Purchasing Gas 18-07-02 Travel related to Purchasing Gas 07-01-04 Other Shopping (not groceries, food, and gas) 18-07-04 Travel related to Other Shopping (not groceries, food, gas) 07-01-05 Waiting associated with Shopping 07-01-99 Other Shopping Activities 07-02 Researching Purchases 07-03 Security Procedures related to Purchases 07-99 Consumer Purchases - Other Activities 07-07-99 Other Consumer Purchases 18-07-99 Travel related to Other Consumer Purchases 16-01-04 Telephone Calls with Salespeople	Photographic equipment (L4, 45) Recreational books (L3, 58) Games, toys, and hobbies (L4, 125) Film and photographic supplies (L4, 128) Tobacco (L3, 139) Magazines, newspapers, and stationery (L3, 140) Photo processing (L4, 218) Photo studios (L4, 219) Repair and rental of audio-visual, photographic, and information processing equipment (L4, 220) **Proportional Consumption Expenditures**: New motor vehicles (L3, 5) Net purchases of used motor vehicles (L3, 10) Motor vehicle parts and accessories (L3, 18) Gasoline and other energy goods (L2, 111) Other motor vehicle services (L4, 191) Public transportation (L3, 197) Furniture and furnishings (L3, 22) Housing and utilities (L2, 150) Information processing equipment (L4, 46) Jewelry and watches (L3, 61) Telephone and communication equipment (L3, 69) Clothing and footwear (L2, 102) Telecommunication services (L4, 280) Postal and delivery services (L4, 284) Internet access (L4, 287)

Entertainment	12-04 Arts and Entertainment (other than sports)	Amusement parks, campgrounds, ... (L4, 210)
	18-12-04 Travel related to Arts and Entertainment	Motion picture theaters (L5, 212)
	12-05-04 Waiting associated with Arts and Entertainment	Live entertainment (no sports) (L5, 213)
	13-02 Attending Sporting/Recreational Events	Spectator sports (L5, 214)
	18-13-02; Travel related to Attending Sport/Rec. Events	Museums and libraries (L4, 215)
	13-03-02 Waiting related to Attending Sport/Rec. Events	Gambling (L3, 224)
	13-04-02 Security related to Attending Sport/Rec. Events	
		Proportional Consumption Expenditures:
	Proportional Time Use:	New motor vehicles (L3, 5)
	07-01-02 Purchasing Gas	Net purchases of used motor vehicles (L3, 10)
	18-07-02 Travel related to Purchasing Gas	Motor vehicle parts and accessories (L3, 18)
	07-01-04 Other Shopping (not groceries, food, and gas)	Gasoline and other energy goods (L2, 111)
	18-07-04 Travel related to Other Shopping (not groceries, food, gas)	Other motor vehicle services (L4, 191)
	07-01-05 Waiting associated with Shopping	Public transportation (L3, 197)
	07-01-99 Other Shopping Activities	Furniture and furnishings (L3, 22)
	07-02 Researching Purchases	Housing and utilities (L2, 150)
	07-03 Security Procedures related to Purchases	Information processing equipment (L4, 46)
	07-99 Consumer Purchases - Other Activities	Jewelry and watches (L3, 61)
	07-07-99 Other Consumer Purchases	Telephone and communication equipment (L3, 69)
	18-07-99 Travel related to Other Consumer Purchases	Clothing and footwear (L2, 102)
	16-01-04 Telephone Calls with Salespeople	Telecommunication services (L4, 280)
		Postal and delivery services (L4, 284)
		Internet access (L4, 287)

Travel **(for Entertainment)**	18-12-05 Travel as form of entertainment 18-18 Security Procedures Related to Travelling 18-99 Other Travelling **Proportional Time Use**: 07-01-02 Purchasing Gas 18-07-02 Travel related to Purchasing Gas 07-01-04 Other Shopping (not groceries, food, and gas) 18-07-04 Travel related to Other Shopping (not groceries, food, gas) 07-01-05 Waiting associated with Shopping 07-01-99 Other Shopping Activities 07-02 Researching Purchases 07-03 Security Procedures related to Purchases 07-99 Consumer Purchases - Other Activities 07-07-99 Other Consumer Purchases 18-07-99 Travel related to Other Consumer Purchases 16-01-04 Telephone Calls with Salespeople	Luggage and similar personal items (L3, 68) Package tours (L4, 230) **Proportional Consumption Expenditures**: New motor vehicles (L3, 5) Net purchases of used motor vehicles (L3, 10) Motor vehicle parts and accessories (L3, 18) Gasoline and other energy goods (L2, 111) Other motor vehicle services (L4, 191) Public transportation (L3, 197) Information processing equipment (L4, 46) Jewelry and watches (L3, 61) Telephone and communication equipment (L3, 69) Clothing and footwear (L2, 102) Telecommunication services (L4, 280) Postal and delivery services (L4, 284) Internet access (L4, 287) Accommodations (L3, 247)

Market Work and Related Activities	05-01 Working 18-05-01 Travel related to Working 05-02 Work-related Activities 18-05-02 Travel related to Work-related Activities 05-03 Other income-generating activities 18-05-03 Travel related to income-generating activities 05-04 Job Search and Interviewing 18-05-04 Travel related to Job Search and Interviewing 05-99 Other Work Activities 18-05-99 Travel related to Other Work Activities **Proportional Time Use**: 07-01-02 Purchasing Gas 18-07-02 Travel related to Purchasing Gas	No related consumption expenditures
Sleeping	01-01 Personal Care - Sleeping	No related consumption expenditures

Education	06-01 Taking Class 18-06-01 Travel related to Taking Class 06-02 Extracurricular Activities (no sport) 18-06-02 Travel related to Extracur. Activities (no sport) 06-03 Research/Homework 18-06-03 Travel related to Research/Homework 06-04 Registration/Administrative Activities 18-06-04 Travel related to Registration/Administr. 06-99 Other Educational Activities 18-06-99 Travel related to Other Educational Activities 16-01-03 Telephone Calls with Education Services Providers **Proportional Time Use**: 07-01-02 Purchasing Gas 18-07-02 Travel related to Purchasing Gas 07-01-04 Other Shopping (not groceries, food, and gas) 18-07-04 Travel related to Other Shopping (not groceries, food, gas) 07-01-05 Waiting associated with Shopping 07-01-99 Other Shopping Activities 07-02 Researching Purchases 07-03 Security Procedures related to Purchases 07-99 Consumer Purchases - Other Activities 07-07-99 Other Consumer Purchases 18-07-99 Travel related to Other Consumer Purchases 16-01-04 Telephone Calls with Salespeople	Educational books (L3, 67) Education services (L3, 288) **Proportional Consumption Expenditures**: New motor vehicles (L3, 5) Net purchases of used motor vehicles (L3, 10) Motor vehicle parts and accessories (L3, 18) Gasoline and other energy goods (L2, 111) Other motor vehicle services (L4, 191) Public transportation (L3, 197) Furniture and furnishings (L3, 22) Housing and utilities (L2, 150) Information processing equipment (L4, 46) Jewelry and watches (L3, 61) Telephone and communication equipment (L3, 69) Clothing and footwear (L2, 102) Telecommunication services (L4, 280) Postal and delivery services (L4, 284) Internet access (L4, 287) Accommodations (L3, 247)

Health, Accidents, and Emergencies	01-03 Health-related self care 01-05 Personal care emergencies 02-99 Other Emergencies and Accidents 18-02-99 Travel related to Other Emergencies and Accidents 08-04 Medical and Care Services 18-08-04 Travel related to Medical and Care Services 10-01-01 Using Police and Fire Services **Proportional Time Use**: 07-01-02 Purchasing Gas 18-07-02 Travel related to Purchasing Gas 07-01-04 Other Shopping (not groceries, food, and gas) 18-07-04 Travel related to Other Shopping (not groceries, food, gas) 07-01-05 Waiting associated with Shopping 07-01-99 Other Shopping Activities 07-02 Researching Purchases 07-03 Security Procedures related to Purchases 07-99 Consumer Purchases - Other Activities 07-07-99 Other Consumer Purchases 18-07-99 Travel related to Other Consumer Purchases 16-01-04 Telephone Calls with Salespeople	Therapeutic appliances and equipment (L3, 64) Pharmaceutical and medical products (L3, 119) Health care (L2, 170) **Proportional Consumption Expenditures**: New motor vehicles (L3, 5) Net purchases of used motor vehicles (L3, 10) Motor vehicle parts and accessories (L3, 18) Gasoline and other energy goods (L2, 111) Other motor vehicle services (L4, 191) Public transportation (L3, 197) Furniture and furnishings (L3, 22) Housing and utilities (L2, 150) Information processing equipment (L4, 46) Jewelry and watches (L3, 61) Telephone and communication equipment (L3, 69) Clothing and footwear (L2, 102) Telecommunication services (L4, 280) Postal and delivery services (L4, 284) Internet access (L4, 287)

Child Care	03-01 Caring for/helping household members (children) 18-03-01 Travel related to Caring for/helping children 03-02 Activities related to children's education 18-03-02 Travel related to children's education 03-03 Activities related to children's health 18-03-03 Travel related to children's health 04-01 Caring for/helping for children (non-hh member) 18-04-01 Travel related to Caring for/helping for children (non-hh member) 04-02 Activities related to children's education (non-hh member) 18-04-02 Travel related to household members children's education (non-hh member) 04-03 Activities related to children's health (non-hh member) 18-04-03 Travel related to children's health (non-hh member) 08-01 Childcare Services 18-08-01 Travel related to Childcare Services **Proportional Time Use**: 07-01-02 Purchasing Gas 18-07-02 Travel related to Purchasing Gas 07-01-04 Other Shopping (not groceries, food, and gas) 18-07-04 Travel related to Other Shopping (not groceries, food, gas) 07-01-05 Waiting associated with Shopping 07-01-99 Other Shopping Activities 07-02 Researching Purchases 07-03 Security Procedures related to Purchases 07-99 Consumer Purchases - Other Activities 07-07-99 Other Consumer Purchases 18-07-99 Travel related to Other Consumer Purchases 16-01-04 Telephone Calls with Salespeople	Child care (L4, 314) **Proportional Consumption Expenditures**: New motor vehicles (L3, 5) Net purchases of used motor vehicles (L3, 10) Motor vehicle parts and accessories (L3, 18) Gasoline and other energy goods (L2, 111) Other motor vehicle services (L4, 191) Public transportation (L3, 197) Furniture and furnishings (L3, 22) Housing and utilities (L2, 150) Information processing equipment (L4, 46) Jewelry and watches (L3, 61) Telephone and communication equipment (L3, 69) Clothing and footwear (L2, 102) Telecommunication services (L4, 280) Postal and delivery services (L4, 284) Internet access (L4, 287)

Others Care, and Social Services	03-04 Caring for household adults 18-03-04 Travel related to caring for household adults 03-05 Helping household adults 18-03-05 Travel related to helping household adults 03-99 Caring for/helping household members - other 18-03-99 Travel related to caring for/helping household members 04-04 Caring for non-household adults 18-04-04 Travel related to caring for non-hh adults 04-05 Helping non-household adults 18-04-05 Travel related to helping non-hh adults 04-99 Caring for/helping non-hh members - other activities 18-04-99 Travel related to caring for/helping non-hh members 10-01-02 Using Social Services 10-01-99 Other activities related to Government Services 10-99 Other government services 18-10-99 Travel related to other government services 15-02 Volunteer Activities (Social Service, Care Activities) 16-01-07 Telephone Calls with child/adult care providers **Proportional Time Use**: 07-01-02 Purchasing Gas 18-07-02 Travel related to Purchasing Gas 07-01-04 Other Shopping (not groceries, food, and gas) 18-07-04 Travel related to Other Shopping (not groceries, food, gas) 07-01-05 Waiting associated with Shopping 07-01-99 Other Shopping Activities 07-02 Researching Purchases 07-03 Security Procedures related to Purchases 07-99 Consumer Purchases - Other Activities 07-07-99 Other Consumer Purchases 18-07-99 Travel related to Other Consumer Purchases 16-01-04 Telephone Calls with Salespeople	Social assistance (L4, 315) **Proportional Consumption Expenditures**: New motor vehicles (L3, 5) Net purchases of used motor vehicles (L3, 10) Motor vehicle parts and accessories (L3, 18) Gasoline and other energy goods (L2, 111) Other motor vehicle services (L4, 191) Public transportation (L3, 197) Furniture and furnishings (L3, 22) Housing and utilities (L2, 150) Information processing equipment (L4, 46) Jewelry and watches (L3, 61) Telephone and communication equipment (L3, 69) Clothing and footwear (L2, 102) Telecommunication services (L4, 280) Postal and delivery services (L4, 284) Internet access (L4, 287)

Civic, and Religious Activities	10-02 Civic Obligations/Participation 18-10-02 Travel related to Civic Obligations/Participation 10-03 Waiting Associated with Civic Obligations 10-04 Security procedures related to Civic Obligations 14-01 Religious/Spiritual Practices 18-14 Travel related to Religious/Spiritual Practices 14-99 Other Religious and Spiritual Activities 15-01 Volunteer Activities - Administrative/Support 15-03 Volunteer Activities - Indoor/Outdoor Maintenance 15-04 Volunteer Activities - Participation Cultural Activities 15-05 Volunteer Activities - Meetings, Conferences, Training 15-06 Volunteer Activities - Public Health/Safety Activities 15-07 Waiting Associated with Volunteer Activities 15-08 Security Procedures related to Volunteer Activities 15-99 Other Volunteer Activities 18-15 Travel related to Volunteer Activities 16-01-08 Telephone Calls with government officials **Proportional Time Use**: 07-01-02 Purchasing Gas 18-07-02 Travel related to Purchasing Gas 07-01-04 Other Shopping (not groceries, food, and gas) 18-07-04 Travel related to Other Shopping (not groceries, food, gas) 07-01-05 Waiting associated with Shopping 07-01-99 Other Shopping Activities 07-02 Researching Purchases 07-03 Security Procedures related to Purchases 07-99 Consumer Purchases - Other Activities 07-07-99 Other Consumer Purchases 18-07-99 Travel related to Other Consumer Purchases 16-01-04 Telephone Calls with Salespeople	Social advocacy, civic/social organizations (L4, 322) Religious organizations' services (L4, 323) Foundations and grantmaking and giving services to households (L4, 324) **Proportional Consumption Expenditures**: New motor vehicles (L3, 5) Net purchases of used motor vehicles (L3, 10) Motor vehicle parts and accessories (L3, 18) Gasoline and other energy goods (L2, 111) Other motor vehicle services (L4, 191) Public transportation (L3, 197) Furniture and furnishings (L3, 22) Housing and utilities (L2, 150) Information processing equipment (L4, 46) Jewelry and watches (L3, 61) Telephone and communication equipment (L3, 69) Clothing and footwear (L2, 102) Telecommunication services (L4, 280) Postal and delivery services (L4, 284) Internet access (L4, 287)

Appendix B. Robustness: Empirical Results

Activity	Weekly Hours (1)	Weekly Real Expenditure (2)	Time Intensity (min per unit) (3)
Entertainment	1.19	56.88	1.25
Household Management	1.71	42.67	2.41
Cooking, Cleaning, Eating, Drinking	17.88	418.53	2.56
Animals and Pets	0.93	20.52	2.72
Home Maintenance and Gardening	2.87	63.24	2.73
Travel (as a form of entertainment)	0.42	8.75	2.87
Sports and Exercise	2.42	39.53	3.67
Personal Care	5.27	55.49	5.70
Socializing, Relaxing and Hobbies	12.99	63.93	12.20
TV, Radio, Music	18.36	47.53	23.18

Table B.1: Time Intensity across Consumption Activities. Column (1) reports average weekly hours from ATUS. Column (2) reports average weekly real activity-specific per-capita consumption expenditures, excluding proportionally allocated items (nominal expenditures deflated by the total PCE price index, base year 2012). Column (3) reports time intensity, defined as average weekly minutes per unit of real activity-specific expenditure. Activities are sorted by ascending time intensity. Sample period: 2003–2019.

Activity	Weekly Hours (1)	Weekly Real Expenditure (2)	Time Intensity (min per unit) (3)
Entertainment	1.19	73.37	0.97
Household Management	1.71	67.23	1.53
Cooking, Cleaning, Eating, Drinking	17.88	675.63	1.59
Travel (as a form of entertainment)	0.42	15.65	1.60
Animals and Pets	0.93	34.44	1.62
Home Maintenance and Gardening	2.87	103.41	1.67
Sports and Exercise	2.42	72.64	2.00
Personal Care	5.27	129.31	2.45
Socializing, Relaxing and Hobbies	12.99	247.44	3.15
TV, Radio, Music	18.36	214.77	5.13

Table B.2: Time Intensity across Consumption Activities. Column (1) reports average weekly hours from ATUS. Column (2) reports average weekly real per-capita consumption expenditures, where nominal expenditures are deflated by the activity-level price index P_j (base year 2012) rather than the total PCE price index. Column (3) reports time intensity, defined as average weekly minutes per unit of activity j's own real consumption bundle. Activities are sorted by ascending time intensity. The ranking coincides with that in Table 1. Sample period: 2003–2019.

Activity	Time Reallocation Coefficient $\hat{\beta}^j$ (1)	Time Cyclicality ε^j (2)
Education	0.057 (0.006)	0.84
Health, Accidents and Emergencies	0.021 (0.003)	0.60
Entertainment	0.021 (0.003)	0.53
Home Maintenance and Gardening	0.053 (0.005)	0.53
Others Care and Social Services	0.027 (0.003)	0.53
Sports and Exercise	0.041 (0.004)	0.52
Travel (as a form of entertainment)	0.007 (0.002)	0.48
Household Management	0.025 (0.003)	0.43
Socializing, Relaxing and Hobbies	0.164 (0.009)	0.39
TV, Radio, Music	0.204 (0.009)	0.35
Animals and Pets	0.009 (0.002)	0.28
Child Care	0.040 (0.004)	0.27
Civic and Religious Activities	0.016 (0.003)	0.27
Cooking, Cleaning, Eating, Drinking	0.132 (0.006)	0.23
Sleeping	0.194 (0.007)	0.10
Personal Care	-0.012 (0.002)	-0.07

Table B.3: Time Cyclicality across Consumption Activities. Column (1) reports the estimated time reallocation coefficient between market hours and time spent on each activity ($\hat{\beta}^j$), based on the AHK regression using year-over-year changes at quarterly frequency, with standard errors in parentheses. All coefficients are statistically significant at the 1% level. Column (2) presents the implied time-use elasticities. Activities in italics are excluded from the core set in the main analysis. By construction, the $\hat{\beta}^j$ across the exhaustive set of activities sum to one. Sample period: 2003–2019.

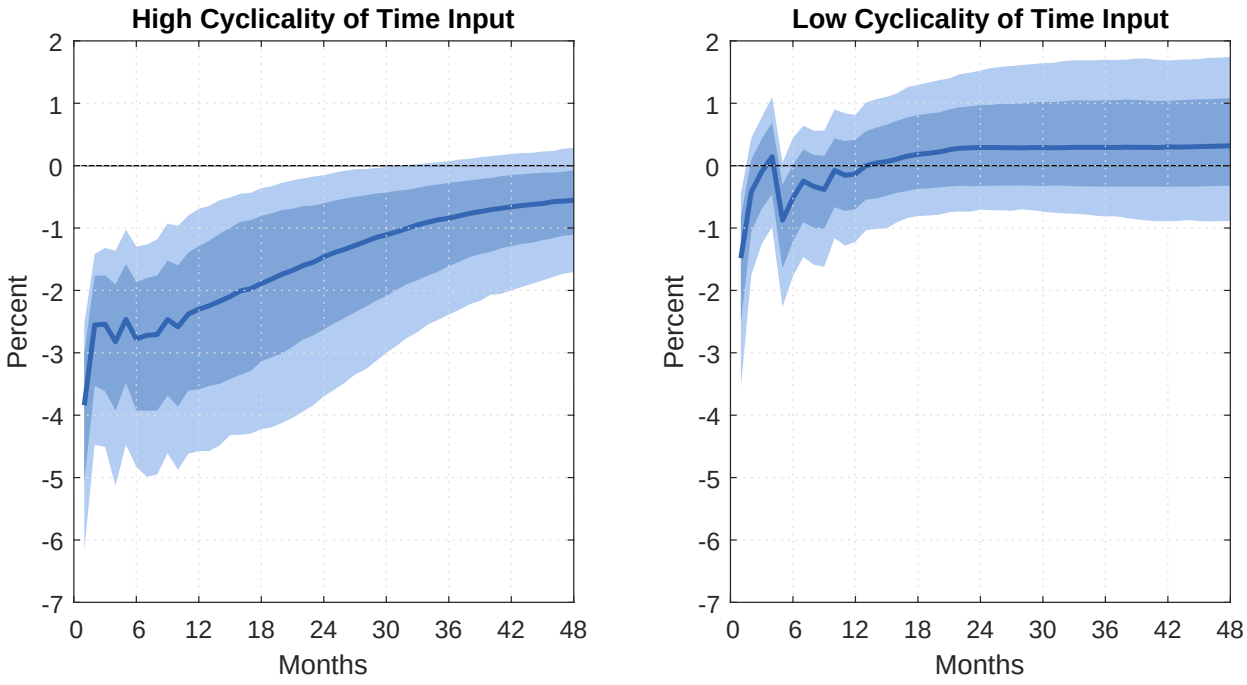


Figure B.1: Estimated impulse responses of real, **activity-specific consumption expenditures** (excluding proportional expenditures), relative to total real consumption expenditures, for activities with strongly and weakly cyclical time inputs, following a contractionary monetary policy shock. Shaded areas denote 90% and 68% confidence intervals. The responses are estimated using monthly data from 1988:02–2019:12, with the shock—taken from Bauer and Swanson, 2023—normalized to a 100 basis-point increase in the one-year government bond yield.

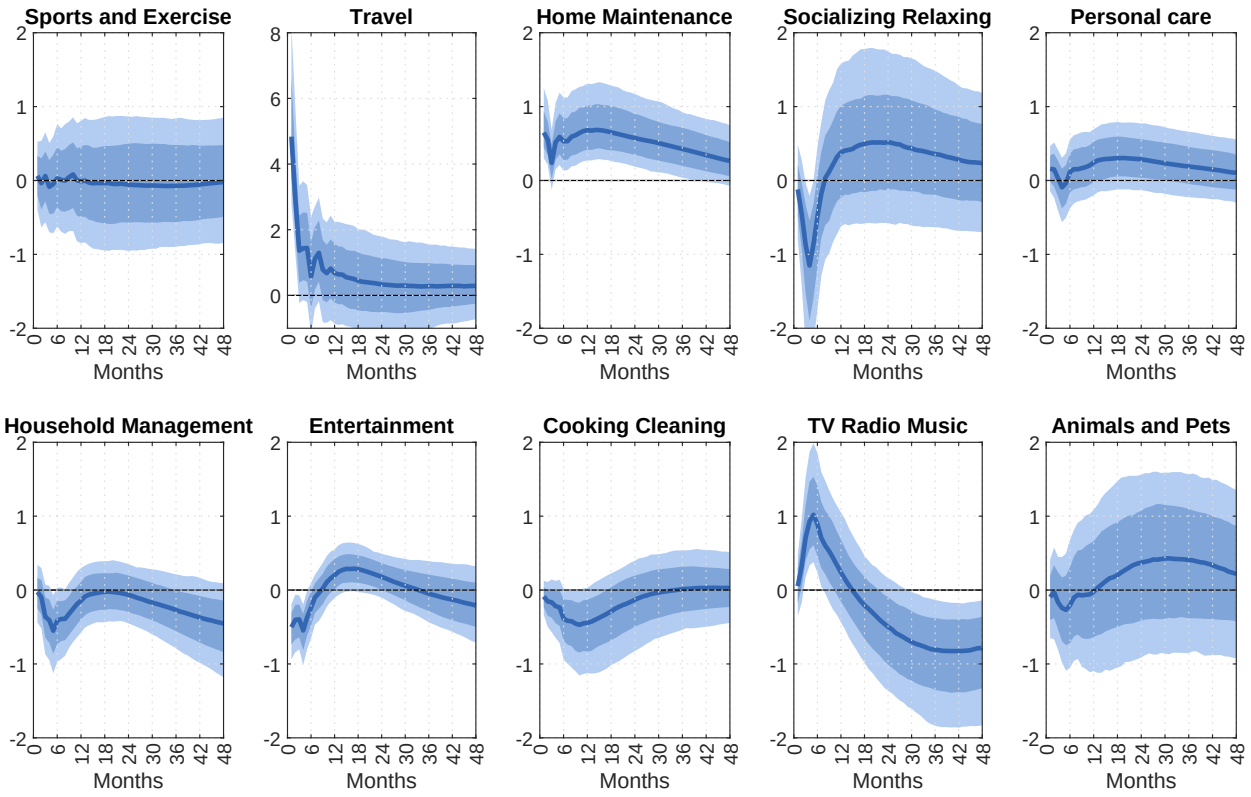


Figure B.2: Estimated impulse responses of **relative prices for each activities**, following a contractionary monetary policy shock. Shaded areas denote 90% and 68% confidence intervals. The responses are estimated using monthly data from 1988:02–2019:12, with the shock—taken from Bauer and Swanson, 2023—normalized to a 100 basis-point increase in the one-year government bond yield.

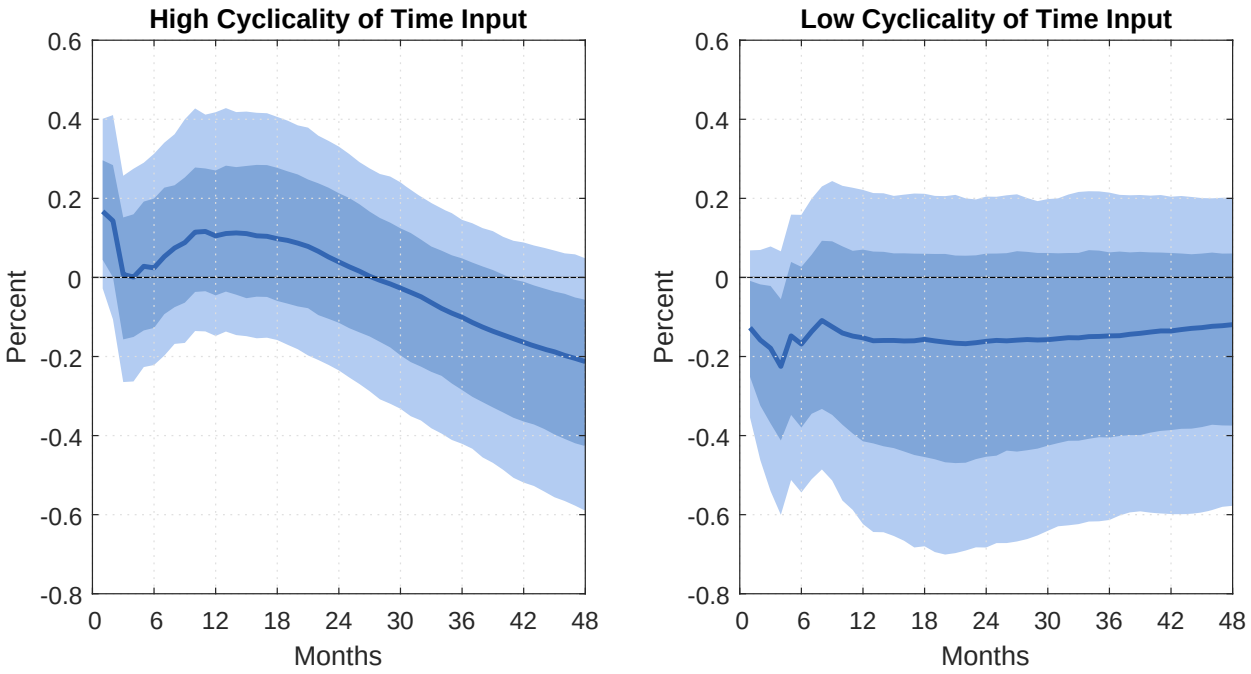


Figure B.3: Estimated impulse responses of relative prices for activities with strongly and weakly cyclical time inputs, following a contractionary monetary policy shock. Shaded areas denote 90% and 68% confidence intervals. The responses are estimated using monthly data from 1988:02–2019:12, with the shock—taken from Bauer and Swanson, 2023—normalized to a 100 basis-point increase in the one-year government bond yield.

Appendix C. The Model

Appendix C.1. The Household's problem and first-order conditions

In this section we lay out the household's problem and the corresponding first-order conditions. Given an initial value of assets B_0 and all prices and policies, the representative household chooses a state-contingent sequence for $C_{1,t}$, $C_{2,t}$, $h_{1,t}$, $h_{2,t}$, $X_{1,t}$, $X_{2,t}$, $h_{m,t}$, l_t, and B_{t+1}, $t \geq 0$, to maximize lifetime utility,

$$\mathbb{E}_t \sum_{t=0}^{\infty} \beta^t U(C_t, l_t),$$

subject to technology,

$$\begin{aligned} 1 &= h_{m,t} + h_{1,t} + h_{2,t} + l_t, \\ C_t &= \left[\alpha C_{1,t}^b + (1-\alpha) C_{2,t}^b\right]^{\frac{1}{b}}, \qquad b < 1, \\ C_{1,t} &= \left[\alpha_1 X_{1,t}^{b_1} + (1-\alpha_1) h_{1,t}^{b_1}\right]^{\frac{1}{b_1}}, \quad b_1 < 1, \quad \alpha_1 \in [0,1], \\ C_{2,t} &= \left[\alpha_2 X_{2,t}^{b_2} + (1-\alpha_2) h_{2,t}^{b_2}\right]^{\frac{1}{b_2}}, \quad b_2 < 1, \quad \alpha_2 \in [0,1], \end{aligned} \tag{C.1}$$

and the flow budget constraint,

$$B_t + W_t h_{m,t} + T_t \geq \mathbb{E}_t \left\{Q_{t,t+1} B_{t+1}\right\} + P_{1,t} X_{1,t} + P_{2,t} X_{2,t}. \tag{C.2}$$

The Lagrangian can be defined as follows:

$$\begin{aligned} \mathcal{L} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \Big\{ & U\left[\left(\alpha C_{1,t}^b + (1-\alpha) C_{2,t}^b\right)^{\frac{1}{b}}, 1 - h_{m,t} - h_{1,t} - h_{2,t}\right] \\ & + \mu_{1,t}\left[\left[\alpha_1 X_{1,t}^{b_1} + (1-\alpha_1) h_{1,t}^{b_1}\right]^{\frac{1}{b_1}} - C_{1,t}\right] \\ & + \mu_{2,t}\left[\left[\alpha_2 X_{2,t}^{b_2} + (1-\alpha_2) h_{2,t}^{b_2}\right]^{\frac{1}{b_2}} - C_{2,t}\right] \\ & + \lambda_t \left[B_t + W_t h_{m,t} + T_t - \mathbb{E}_t \left\{Q_{t,t+1} B_{t+1}\right\} - P_{1,t} X_{1,t} - P_{2,t} X_{2,t}\right] \Big\}, \end{aligned} \tag{C.3}$$

where the Lagrange multiplier λ_t represents the marginal utility of nominal wealth. The corresponding first-order conditions are

$$\{C_{1,t}\}: \quad \mu_{1,t} = U_C(C_t, l_t) \alpha \left(\frac{C_{1,t}}{C_t}\right)^{b-1}, \tag{C.4}$$

$$\{C_{2,t}\}: \ \mu_{2,t} \ = \ U_C(C_t, l_t)(1-\alpha)\left(\frac{C_{2,t}}{C_t}\right)^{b-1}, \tag{C.5}$$

$$\{h_{m,t}\}: \ \lambda_t W_t \ = \ U_l(C_t, l_t), \tag{C.6}$$

$$\{h_{1,t}\}: \ U_l(C_t, l_t) \ = \ \mu_{1,t}(1-\alpha_1)\left(\frac{h_{1,t}}{C_{1,t}}\right)^{b_1-1}, \tag{C.7}$$

$$\{h_{2,t}\}: \ U_l(C_t, l_t) \ = \ \mu_{2,t}(1-\alpha_2)\left(\frac{h_{2,t}}{C_{2,t}}\right)^{b_2-1}, \tag{C.8}$$

$$\{X_{1,t}\}: \ \mu_{1,t}\alpha_1\left(\frac{X_{1,t}}{C_{1,t}}\right)^{b_1-1} \ = \ \lambda_t P_{1,t}, \tag{C.9}$$

$$\{X_{2,t}\}: \ \mu_{2,t}\alpha_2\left(\frac{X_{2,t}}{C_{2,t}}\right)^{b_2-1} \ = \ \lambda_t P_{2,t}, \tag{C.10}$$

$$\{B_{t+1}\}: \ \lambda_t \mathbb{E}_t\left\{Q_{t,t+1}\right\} = \beta \mathbb{E}_t\left\{\lambda_{t+1}\right\}. \tag{C.11}$$

After defining for convenience

$$\lambda_{1,t} \equiv \alpha U_C(C_t, l_t)\left(\frac{C_{1,t}}{C_t}\right)^{b-1}\alpha_1\left(\frac{X_{1,t}}{C_{1,t}}\right)^{b_1-1} \tag{C.12}$$

and

$$\lambda_{2,t} \equiv (1-\alpha) U_C(C_t, l_t)\left(\frac{C_{2,t}}{C_t}\right)^{b-1}\alpha_2\left(\frac{X_{2,t}}{C_{2,t}}\right)^{b_2-1}, \tag{C.13}$$

which represent marginal utilities of $X_{1,t}$ and $X_{2,t}$, we can rearrange the system as follows

$$\frac{P_{1,t}}{P_{2,t}} = \frac{\lambda_{1,t}}{\lambda_{2,t}}, \tag{C.14}$$

$$\beta(1+i_t)\mathbb{E}_t\left\{\frac{\lambda_{1,t+1}}{\lambda_{1,t}}\Pi_{1,t+1}^{-1}\right\} = 1, \tag{C.15}$$

$$\frac{U_l(C_t, l_t)}{\lambda_{1,t}} = \frac{W_t}{P_{1,t}}, \tag{C.16}$$

$$\frac{W_t}{P_{1,t}} = \frac{1-\alpha_1}{\alpha_1}\left(\frac{X_{1,t}}{h_{1,t}}\right)^{1-b_1}, \tag{C.17}$$

$$\frac{W_t}{P_{2,t}} = \frac{1-\alpha_2}{\alpha_2}\left(\frac{X_{2,t}}{h_{2,t}}\right)^{1-b_2}, \tag{C.18}$$

$$\lambda_t P_{1,t} = \lambda_{1,t} \;\Rightarrow \lambda_t = \frac{\lambda_{1,t}}{P_{1,t}}, \tag{C.19}$$

where $\Pi_{1,t} \equiv P_{1,t}/P_{1,t-1}$.[22] Equation (C.19) serves the only purpose of retrieving the marginal utility of nominal wealth, λ_t, or the marginal utility of real wealth, $\lambda_t P_{1,t}$.

Appendix C.2. Firms

In the economy, there are two sectors, each populated by infinitely many monopolistically competitive firms indexed by $i \in [0,1]$. Each firm buys hours worked on perfectly competitive markets in order to produce a variety i according to the following production functions:

$$X_{j,t}(i) = Z_{j,t} h_{m,j,t}(i), \quad j \in \{1,2\}. \tag{C.20}$$

Cost minimization trivially yields

$$RMC_{j,t} = \frac{W_t h_{m,j,t}(i)}{P_{j,t} X_{j,t}(i)} = \frac{W_t}{P_{j,t} Z_{j,t}}. \tag{C.21}$$

The real marginal cost, $RMC_{j,t}$, is constant across firms within each sector, because of constant returns to scale in production and perfect competition on factor markets. We follow Calvo (1983) and we assume that in any given period each firm resets its price $P_{j,t}(i)$ with a constant probability $(1-\theta_j)$. At a given price $P_{j,t}(i)$, production has to satisfy demand:

$$X_{j,t}(i) = \left[\frac{P_{j,t}(i)}{P_{j,t}}\right]^{-\varepsilon_j} X_{j,t}, \quad \varepsilon_j > 1, \tag{C.22}$$

[22] Equation (C.14) can be used to alternatively express the Euler equation (C.15) in terms of the price inflation and marginal utility of good X_2.

where aggregate demand, $X_{j,t}$, is taken as given. We further assume that production is subsidized by the government, which pays a fraction τ_j of the unit cost of production. The objective function,

$$\mathbb{E}_t \left\{ \sum_{s=0}^{\infty} \theta_j^s Q_{t,t+s} \left[P_{j,t}(i) X_{j,t+s}(i) - P_{j,t+s}(1-\tau_j) RMC_{j,t+s} X_{j,t+s}(i) \right] \right\}, \tag{C.23}$$

where $Q_{t,t+s}$ denotes the stochastic discount factor in period t for nominal profits s periods ahead,

$$Q_{t,t+s} = \beta^s \mathbb{E}_t \left\{ \frac{\lambda_{j,t+s}}{\lambda_{j,t}} \Pi_{j,t,t+s}^{-1} \right\}, \quad \Pi_{j,t,t+s} \equiv \frac{P_{j,t+s}}{P_{j,t}}, \tag{C.24}$$

is maximized subject to constraint (C.22), yielding the following first-order condition for any firm i that resets its price in t:

$$\mathbb{E}_t \left\{ \sum_{s=0}^{\infty} \theta_j^s Q_{t,t+s} Y_{t+s}(i) \left[\frac{P_{j,t}^*}{P_{j,t}} - \frac{\varepsilon_j (1-\tau_j)}{\varepsilon_j - 1} RMC_{j,t+s} \Pi_{j,t,t+s} \right] \right\} = 0, \tag{C.25}$$

where $P_{j,t}^*$ denotes the optimal price. Also, the following conventional relation between inflation and the optimal reset price holds:

$$\frac{P_{j,t}^*}{P_{j,t}} = \left(\frac{1 - \theta_j \Pi_{j,t}^{\varepsilon_j - 1}}{1 - \theta_j} \right)^{\frac{1}{1-\varepsilon_j}}. \tag{C.26}$$

The necessary condition for profit maximization (C.25) can easily be rewritten as

$$\frac{P_{j,t}^*}{P_{j,t}} \equiv p_{j,t}^* = \frac{K_{j,t}}{F_{j,t}}, \tag{C.27}$$

where the auxiliary variables $K_{j,t}$ and $F_{j,t}$ are recursively defined by

$$\begin{aligned} K_{j,t} &\equiv X_{j,t} \frac{\varepsilon_j (1-\tau_j)}{\varepsilon_j - 1} RMC_{j,t} + \beta \theta_j \mathbb{E}_t \left\{ \frac{\lambda_{j,t+1}}{\lambda_{j,t}} \Pi_{j,t+1}^{\varepsilon_j} K_{j,t+1} \right\}, \\ F_{j,t} &\equiv X_{j,t} + \beta \theta_j \mathbb{E}_t \left\{ \frac{\lambda_{j,t+1}}{\lambda_{j,t}} \Pi_{j,t+1}^{\varepsilon_j - 1} F_{j,t+1} \right\}. \end{aligned} \tag{C.28}$$

Appendix C.3. Market clearing

By the clearing of the labor market,

$$\sum_{j=1}^{2} \int_0^1 h_{m,j,t}(i) \, di = h_{m,t}, \tag{C.29}$$

so that by summing across production functions, (C.20), one obtains

$$\frac{X_{1,t}}{\Delta_{1,t}Z_{1,t}} + \frac{X_{2,t}}{\Delta_{2,t}Z_{2,t}} = h_{m,t}, \tag{C.30}$$

where $\Delta_{j,t}$ denotes relative price dispersion

$$\Delta_{j,t} \equiv \int_0^1 \left(\frac{P_{j,t}(i)}{P_{j,t}}\right)^{-\varepsilon_j} di, \tag{C.31}$$

which evolves according to

$$\Delta_{j,t} = (1-\theta_j)\left(p_{j,t}^*\right)^{-\varepsilon_j} + \theta_j \Pi_{j,t}^{\varepsilon_j} \Delta_{j,t-1}. \tag{C.32}$$

Since $\log(\Delta_{j,t})$ is a second-order term, it can be neglected when the model is approximated to the first order around the non-stochastic steady state.

Appendix D. General Equilibrium

We are now ready to state the general equilibrium as the set of state-contingent sequences for the 29 variables C_t, $C_{1,t}$, $C_{2,t}$, $X_{1,t}$, $X_{2,t}$, $h_{m,t}$, $h_{1,t}$, $h_{2,t}$, l_t, $\lambda_{1,t}$, $\lambda_{2,t}$, $W_t/P_{1,t}$, $P_{1,t}/P_{2,t}$, $\Pi_{1,t}$, $\Pi_{2,t}$, i_t, $P_{1,t}^*$, $P_{2,t}^*$, $K_{1,t}$, $K_{2,t}$, $F_{1,t}$, $F_{2,t}$, $RMC_{1,t}$, $RMC_{2,t}$, $\Delta_{1,t}$, and $\Delta_{2,t}$ that satisfy the following system of equations

$$\alpha U_C(C_t, l_t)\left(\frac{C_{1,t}}{C_t}\right)^{b-1} \alpha_1 \left(\frac{X_{1,t}}{C_{1,t}}\right)^{b_1-1} = \lambda_{1,t}, \tag{D.1}$$

$$\frac{\alpha\left(\frac{C_{1,t}}{C_t}\right)^{b-1} \alpha_1 \left(\frac{X_{1,t}}{C_{1,t}}\right)^{b_1-1}}{(1-\alpha)\left(\frac{C_{2,t}}{C_t}\right)^{b-1} \alpha_2 \left(\frac{X_{2,t}}{C_{2,t}}\right)^{b_2-1}} = \frac{P_{1,t}}{P_{2,t}}, \tag{D.2}$$

$$\frac{U_l(C_t, l_t)}{\lambda_{1,t}} = \frac{W_t}{P_{1,t}}, \tag{D.3}$$

$$\frac{W_t}{P_{1,t}} = \frac{1-\alpha_1}{\alpha_1}\left(\frac{X_{1,t}}{h_{1,t}}\right)^{1-b_1}, \tag{D.4}$$

$$\frac{W_t}{P_{1,t}}\frac{P_{1,t}}{P_{2,t}} = \frac{1-\alpha_2}{\alpha_2}\left(\frac{X_{2,t}}{h_{2,t}}\right)^{1-b_2}, \tag{D.5}$$

$$\beta(1+i_t)\mathbb{E}_t\left\{\frac{\lambda_{1,t+1}}{\lambda_{1,t}}\Pi_{1,t+1}^{-1}\right\} = 1, \tag{D.6}$$

$$(1-\alpha)U_C(C_t,l_t)\left(\frac{C_{2,t}}{C_t}\right)^{b-1}\alpha_2\left(\frac{X_{2,t}}{C_{2,t}}\right)^{b_2-1} = \lambda_{2,t}, \tag{D.7}$$

$$P_{1,t}^* = \left(\frac{1-\theta_1\Pi_{1,t}^{\varepsilon_1-1}}{1-\theta_1}\right)^{\frac{1}{1-\varepsilon_1}}, \tag{D.8}$$

$$P_{2,t}^* = \left(\frac{1-\theta_2\Pi_{2,t}^{\varepsilon_2-1}}{1-\theta_2}\right)^{\frac{1}{1-\varepsilon_2}}, \tag{D.9}$$

$$P_{1,t}^* = \frac{K_{1,t}}{F_{1,t}}, \tag{D.10}$$

$$P_{2,t}^* = \frac{K_{2,t}}{F_{2,t}}, \tag{D.11}$$

$$F_{1,t} = X_{1,t} + \beta\theta_1\mathbb{E}_t\left\{\frac{\lambda_{1,t+1}}{\lambda_{1,t}}\Pi_{1,t+1}^{\varepsilon_1-1}F_{1,t+1}\right\}, \tag{D.12}$$

$$F_{2,t} = X_{2,t} + \beta\theta_2\mathbb{E}_t\left\{\frac{\lambda_{2,t+1}}{\lambda_{2,t}}\Pi_{2,t+1}^{\varepsilon_2-1}F_{2,t+1}\right\}, \tag{D.13}$$

$$K_{1,t} = X_{1,t}\frac{\varepsilon_1(1-\tau)}{\varepsilon_1-1}RMC_{1,t} + \beta\theta_1\mathbb{E}_t\left\{\frac{\lambda_{1,t+1}}{\lambda_{1,t}}\Pi_{1,t+1}^{\varepsilon_1}K_{1,t+1}\right\}, \tag{D.14}$$

$$K_{2,t} = X_{2,t}\frac{\varepsilon_2(1-\tau)}{\varepsilon_2-1}RMC_{2,t} + \beta\theta_2\mathbb{E}_t\left\{\frac{\lambda_{2,t+1}}{\lambda_{2,t}}\Pi_{2,t+1}^{\varepsilon_1}K_{2,t+1}\right\}, \tag{D.15}$$

$$RMC_{1,t} = \frac{W_t}{P_{1,t} Z_{1,t}}, \tag{D.16}$$

$$RMC_{2,t} = \frac{W_t}{P_{2,t} Z_{2,t}}, \tag{D.17}$$

$$\frac{X_{1,t}}{\Delta_{1,t} Z_{1,t}} + \frac{X_{2,t}}{\Delta_{2,t} Z_{2,t}} = h_{m,t}, \tag{D.18}$$

$$\Delta_{1,t} = (1-\theta_1)\left(P^*_{1,t}\right)^{-\varepsilon_1} + \theta_1 \Pi^{\varepsilon_1}_{1,t} \Delta_{1,t-1}, \tag{D.19}$$

$$\Delta_{2,t} = (1-\theta_2)\left(P^*_{2,t}\right)^{-\varepsilon_2} + \theta_2 \Pi^{\varepsilon_2}_{2,t} \Delta_{2,t-1}, \tag{D.20}$$

$$\frac{P_{1,t}}{P_{2,t}} = \frac{P_{1,t-1}}{P_{2,t-1}} \frac{\Pi_{1,t}}{\Pi_{2,t}}, \tag{D.21}$$

$$(1+i_t) = (1+\bar{i}) \left[\left(\frac{\Pi_{1,t}}{\Pi_1} \right)^{\gamma_{\pi_1}} \left(\frac{\Pi_{2,t}}{\Pi_2} \right)^{1-\gamma_{\pi_1}} \right]^{\gamma_\pi} M_t, \tag{D.22}$$

$$C_t = \left[\alpha C^b_{1,t} + (1-\alpha) C^b_{2,t} \right]^{\frac{1}{b}}, \tag{D.23}$$

$$C_{1,t} = \left[\alpha_1 X^{b_1}_{1,t} + (1-\alpha_1) h^{b_1}_{1,t} \right]^{\frac{1}{b_1}}, \tag{D.24}$$

$$C_{2,t} = \left[\alpha_2 X^{b_2}_{2,t} + (1-\alpha_2) h^{b_2}_{2,t} \right]^{\frac{1}{b_2}}, \tag{D.25}$$

$$l_t = 1 - h_{m,t} - h_{1,t} - h_{2,t}, \tag{D.26}$$

together with the laws of motion of three exogenous forces

$$\log Z_{1,t+1} = \rho_{z1} \log Z_{1,t} + \epsilon^{z1}_t, \tag{D.27}$$

$$\log Z_{2,t+1} = \rho_{z2} \log Z_{2,t} + \epsilon_t^{z2}, \tag{D.28}$$

$$\log M_{t+1} = \rho_M \log M_t + \epsilon_t^M, \tag{D.29}$$

and where the following expressions are to be used

$$\begin{aligned} U_C(C_t, l_t) &= \frac{\nu (C_t)^{\nu-1} (l_t)^{1-\nu}}{\left(C_t^{\nu} l_t^{1-\nu}\right)^{\sigma}}, \\ U_l(C_t, l_t) &= -\frac{(\nu-1) C_t^{\nu}}{l_t^{\nu} \left(C_t^{\nu} l_t^{1-\nu}\right)^{\sigma}}. \end{aligned}$$

Appendix E. Price Indices

Appendix E.1. A price index for the special case without time

We start with a canonical two-sector model where no time input is required for consumption activities i.e., $\alpha_1 = \alpha_2 = 1$ so that $h_{1,t} = h_{2,t} = 0$, $C_{1,t} = X_{1,t}$, and $C_{2,t} = X_{2,t}$ for all t, which is a known case in the literature. Combining household's first-order conditions with respect to consumption $C_{1,t} = X_{1,t}$ and $C_{2,t} = X_{2,t}$ with definitions (C.12)-(C.13), yields

$$\lambda_t P_{1,t} = U_C(C_t, l_t) \alpha \left(\frac{C_{1,t}}{C_t}\right)^{b-1}, \qquad \lambda_t P_{2,t} = U_C(C_t, l_t)(1-\alpha) \left(\frac{C_{2,t}}{C_t}\right)^{b-1}, \tag{E.1}$$

which can be further rewritten as

$$C_{1,t} P_{1,t} = \frac{U_C(C_t, l_t)}{\lambda_t} \alpha C_{1,t}^b C_t^{1-b}, \qquad C_{2,t} P_{2,t} = \frac{U_C(C_t, l_t)}{\lambda_t} (1-\alpha) C_{2,t}^b C_t^{1-b}, \tag{E.2}$$

so that total nominal expenditures reads as

$$C_{1,t} P_{1,t} + C_{2,t} P_{2,t} = \frac{U_C(C_t, l_t)}{\lambda_t} C_t^{1-b} \left[\alpha C_{1,t}^b + (1-\alpha) C_{2,t}^b\right], \tag{E.3}$$

which, by making use of (C.1), can be simplified to

$$C_{1,t} P_{1,t} + C_{2,t} P_{2,t} = C_t \frac{U_C(C_t, l_t)}{\lambda_t}. \tag{E.4}$$

We then define the price index,

$$P_t \equiv \frac{U_C(C_t, l_t)}{\lambda_t}, \tag{E.5}$$

so that

$$P_t C_t = C_{1,t} P_{1,t} + C_{2,t} P_{2,t}. \tag{E.6}$$

Hence, total real consumption at an optimum equalizes total nominal expenditures deflated by price index P_t. Now combining (E.5) with (E.1) allows to express relative prices of the two activities:

$$\frac{P_{1,t}}{P_t} = \alpha \left(\frac{C_{1,t}}{C_t} \right)^{b-1}, \qquad \frac{P_{2,t}}{P_t} = (1-\alpha) \left(\frac{C_{2,t}}{C_t} \right)^{b-1} \tag{E.7}$$

which can then be rearranged to standard demand functions:

$$C_{1,t} = \left(\frac{P_{1,t}}{\alpha P_t} \right)^{-\frac{1}{1-b}} C_t, \qquad C_{2,t} = \left(\frac{P_{2,t}}{(1-\alpha) P_t} \right)^{-\frac{1}{1-b}} C_t. \tag{E.8}$$

Finally, we can combine the demand functions for the two activities with the definition of aggregate consumption (C.1) to solve for the aggregate price as a function of market prices,

$$P_t = \left[\alpha^{\frac{1}{1-b}} \left(P_{1,t} \right)^{\frac{b}{b-1}} + (1-\alpha)^{\frac{1}{1-b}} \left(P_{2,t} \right)^{\frac{b}{b-1}} \right]^{\frac{b-1}{b}}. \tag{E.9}$$

The definition is also such that combining (C.6) and (E.5) yields a standard labor supply condition:

$$\frac{W_t}{P_t} = \frac{U_l(C_t, l_t)}{U_C(C_t, l_t)}. \tag{E.10}$$

Appendix E.2. A price index for the general case

We now generalize the previous section to the case of a two-sector model with time use. We first show that we can continue defining the price index as in (E.5), and then we proceed to deriving an expression for the general level of prices as a function of market prices. The household's first-order conditions for $X_{1,t}$ and $X_{2,t}$, together with definitions (C.12)-(C.13), imply

$$\begin{aligned} \lambda_t P_{1,t} X_{1,t} &= \alpha_1 X_{1,t}^{b_1} C_{1,t}^{1-b_1} U_C(C_t, l_t) \alpha \left(\frac{C_{1,t}}{C_t} \right)^{b-1}, \\ \lambda_t P_{2,t} X_{2,t} &= \alpha_2 X_{2,t}^{b_2} C_{2,t}^{1-b_2} U_C(C_t, l_t) (1-\alpha) \left(\frac{C_{2,t}}{C_t} \right)^{b-1}, \end{aligned} \tag{E.11}$$

so that total nominal expenditures are given by

$$X_{1,t}P_{1,t} + X_{2,t}P_{2,t} = \tag{E.12}$$
$$\frac{U_C(C_t, l_t)}{\lambda_t} C_t^{1-b} \left[\alpha_1 X_{1,t}^{b_1} C_{1,t}^{1-b_1} \alpha C_{1,t}^{b-1} + \alpha_2 X_{2,t}^{b_2} C_{2,t}^{1-b_2} (1-\alpha) C_{2,t}^{b-1}\right].$$

Technology (C.1) implies

$$\alpha_1 X_{1,t}^{b_1} C_{1,t}^{1-b_1} = C_{1,t} - (1-\alpha_1) h_{1,t}^{b_1} C_{1,t}^{1-b_1}, \tag{E.13}$$
$$\alpha_2 X_{2,t}^{b_2} C_{2,t}^{1-b_2} = C_{2,t} - (1-\alpha_2) h_{2,t}^{b_2} C_{2,t}^{1-b_2},$$

which can be further rewritten by using (C.12)-(C.14) and (C.16)-(C.19),

$$\alpha_1 X_{1,t}^{b_1} C_{1,t}^{1-b_1} = C_{1,t} - \frac{U_l(C_t, l_t) h_{1,t}}{U_C(C_t, l_t) \alpha C_{1,t}^{b-1} C_t^{1-b}}, \tag{E.14}$$
$$\alpha_2 X_{2,t}^{b_2} C_{2,t}^{1-b_2} = C_{2,t} - \frac{U_l(C_t, l_t) h_{2,t}}{U_C(C_t, l_t)(1-\alpha) C_{2,t}^{b-1} C_t^{1-b}},$$

such that

$$X_{1,t}P_{1,t} + X_{2,t}P_{2,t} = \tag{E.15}$$
$$\frac{U_C(C_t, l_t)}{\lambda_t} C_t^{1-b} \left[\alpha C_{1,t}^{b} + (1-\alpha) C_{2,t}^{b}\right] - \frac{U_l(C_t, l_t)}{\lambda_t} \left[h_{1,t} + h_{2,t}\right] =$$
$$\frac{U_C(C_t, l_t)}{\lambda_t} C_t - W_t \left[h_{1,t} + h_{2,t}\right],$$

where the last equality makes use of equations (C.16) and (C.19). Hence, definition (E.5) implies

$$P_t C_t = X_{1,t}P_{1,t} + X_{2,t}P_{2,t} + W_t(h_{1,t} + h_{2,t}), \tag{E.16}$$

so that, also in this case, total real consumption at an optimum equalizes total nominal expenditures, deflated by price index P_t. However, differently from the conventional two-sector model, total nominal expenditures must include the opportunity cost of time devoted to consumption activities. One can also easily show that evaluating consumption activities

at their marginal utility yields the following expression for aggregate nominal consumption,

$$\frac{U_C(C_t,l_t)}{\lambda_t}\alpha\left(\frac{C_{1,t}}{C_t}\right)^{b-1}C_{1,t}+\frac{U_C(C_t,l_t)}{\lambda_t}(1-\alpha)\left(\frac{C_{2,t}}{C_t}\right)^{b-1}= \tag{E.17}$$
$$P_t\alpha\left(\frac{C_{1,t}}{C_t}\right)^{b-1}C_{1,t}+P_t(1-\alpha)\left(\frac{C_{2,t}}{C_t}\right)^{b-1}=$$
$$P_tC_t,$$

where the first equality applies definition (E.5), and the last equality makes use of equations (C.1). Hence, the following equations,

$$P^c_{1,t}\equiv P_t\alpha\left(\frac{C_{1,t}}{C_t}\right)^{b-1},\quad P^c_{2,t}\equiv P_t(1-\alpha)\left(\frac{C_{2,t}}{C_t}\right)^{b-1}, \tag{E.18}$$

naturally define the shadow price of activities $C_{1,t}$ and $C_{2,t}$, and they can be interpreted as conventional demand functions,

$$C_{1,t}=\left(\frac{P^c_{1,t}}{\alpha P_t}\right)^{-\frac{1}{1-b}}C_t,\qquad C_{2,t}=\left(\frac{P^c_{2,t}}{(1-\alpha)P_t}\right)^{-\frac{1}{1-b}}C_t, \tag{E.19}$$

implying that

$$P^c_{1,t}C_{1,t}+P^c_{2,t}C_{2,t}=P_tC_t=X_{1,t}P_{1,t}+X_{2,t}P_{2,t}+W_t(h_{1,t}+h_{2,t}). \tag{E.20}$$

Further combining definitions (C.12)-(C.13), (E.5) and (E.18) with labor supply functions (C.17)-(C.18) yield standard demand functions for market inputs,

$$X_{1,t}=\left(\frac{P_{1,t}}{\alpha_1P^c_{1,t}}\right)^{-\frac{1}{1-b_1}}C_{1,t},\qquad X_{2,t}=\left(\frac{P_{2,t}}{\alpha_2P^c_{2,t}}\right)^{-\frac{1}{1-b_2}}C_{2,t}, \tag{E.21}$$

and time,

$$h_{1,t}=\left(\frac{W_t}{(1-\alpha_1)P^c_{1,t}}\right)^{-\frac{1}{1-b_1}}C_{1,t},\qquad h_{2,t}=\left(\frac{W_t}{(1-\alpha_2)P^c_{2,t}}\right)^{-\frac{1}{1-b_2}}C_{2,t}, \tag{E.22}$$

for each activity. Finally, one can obtain expressions for price indexes as function of market prices by using demand functions into technology constraints (C.1):

$$P_{1,t}^{c} = \left[\alpha_1^{\frac{1}{1-b_1}} P_{1,t}^{-\frac{b_1}{1-b_1}} + (1-\alpha_1)^{\frac{1}{1-b_1}} W_t^{-\frac{b_1}{1-b_1}}\right]^{-\frac{1-b_1}{b_1}}, \tag{E.23}$$

$$P_{2,t}^{c} = \left[\alpha_2^{\frac{1}{1-b_2}} P_{2,t}^{-\frac{b_2}{1-b_2}} + (1-\alpha_2)^{\frac{1}{1-b_2}} W_t^{-\frac{b_2}{1-b_2}}\right]^{-\frac{1-b_2}{b_2}}, \tag{E.24}$$

$$P_t = \left[\alpha^{\frac{1}{1-b}} \left(P_{1,t}^{c}\right)^{-\frac{b}{1-b}} + (1-\alpha)^{\frac{1}{1-b}} \left(P_{2,t}^{c}\right)^{-\frac{b}{1-b}}\right]^{-\frac{1-b}{b}}. \tag{E.25}$$

We have thus shown that, as for a two-sector model without home production, a price index can be defined and expressed solely as a function of market prices. Since, however, time is relevant for the overall utility brought about by market expenditures on consumption goods, the nominal wage must be factored in. In other words, the value of consumption may fluctuate even if the market price for goods and services or leisure time do not, insofar time is reallocated across consumption activities due to fluctuations in wages. Such welfare-relevant fluctuations are not captured by conventional macroeconomic aggregates or price indices, and it can only be accounted for by explicitly factoring in fluctuations in time use.

As for the special case, combining (C.6) and (E.5) yields a standard labor supply condition:

$$\frac{W_t}{P_t} = \frac{U_l(C_t, l_t)}{U_C(C_t, l_t)}. \tag{E.26}$$

Appendix F. Flexible-price equilibrium and steady-state

Appendix F.1. Flexible-price equilibrium

At a flexible-price equilibrium ($\theta_j = 0$) equations (C.26) and (C.32) imply that $p_{j,t}^{*} = 1$ and $\Delta_{j,t} = 1$. As a result, $F_{j,t} = K_{j,t} = X_{j,t}$ from equation (C.27), whereas $RMC_{j,t} = 1$ follows from equations (C.28) and the assumption that $\tau_j = 1/\varepsilon_j$. Therefore, the equations that describe the solution to the firms' problem and the clearing of markets can be reduced to

$$Z_{1,t} = \frac{W_t}{P_{1,t}}, \quad Z_{2,t} = \frac{W_t}{P_{2,t}} \Rightarrow \quad \frac{P_{1,t}}{P_{2,t}} = \frac{Z_{2,t}}{Z_{1,t}}, \tag{F.1}$$

and

$$W_t h_{m,t} = P_{1,t} X_{1,t} + P_{2,t} X_{2,t}, \tag{F.2}$$

whereas households' optimality conditions (C.14),

$$\frac{P_{1,t}}{P_{2,t}} = \frac{\alpha}{1-\alpha}\left(\frac{C_{1,t}}{C_{2,t}}\right)^{b-1}\frac{\alpha_1\left(\frac{X_{1,t}}{C_{1,t}}\right)^{b_1-1}}{\alpha_2\left(\frac{X_{2,t}}{C_{2,t}}\right)^{b_2-1}}, \tag{F.3}$$

and (C.16),

$$\frac{U_l(C_t,l_t)}{\lambda_{1,t}} = \frac{1-\nu}{\nu}\frac{C_t}{l_t}\frac{1}{\alpha\alpha_1}\left(\frac{C_{1,t}}{C_t}\right)^{1-b}\left(\frac{X_{1,t}}{C_{1,t}}\right)^{1-b_1} = \frac{W_t}{P_{1,t}}, \tag{F.4}$$

hold together with (C.17)-(C.18) and technological constraints (C.1). The combination of the aggregate resource constraint, (F.2), with the demand for time in consumption activities, (C.17)-(C.18), yields the total market value of non-leisure time,

$$\begin{aligned}
&\frac{W_t}{P_{1,t}}(h_{m,t}+h_{1,t}+h_{2,t}) = X_{1,t} + \frac{1-\alpha_1}{\alpha_1}X_{1,t}^{1-b_1}h_{1,t}^{b_1} + \frac{P_{2,t}}{P_{1,t}}\left[X_{2,t} + \frac{1-\alpha_2}{\alpha_2}X_{2,t}^{1-b_2}h_{2,t}^{b_2}\right]\\
&= \frac{1}{\alpha_1}X_{1,t}^{1-b_1}\left[\alpha_1 X_{1,t}^{b_1} + (1-\alpha_1)h_{1,t}^{b_1}\right] + \frac{P_{2,t}}{P_{1,t}}\frac{1}{\alpha_2}X_{2,t}^{1-b_2}\left[\alpha_2 X_{2,t}^{b_2} + (1-\alpha_2)h_{2,t}^{b_2}\right]\\
&= \frac{1}{\alpha_1}X_{1,t}^{1-b_1}C_{1,t}^{b_1} + \frac{P_{2,t}}{P_{1,t}}\frac{1}{\alpha_2}X_{2,t}^{1-b_2}C_{2,t}^{b_2}\\
&= \frac{1}{\alpha_1}X_{1,t}^{1-b_1}C_{1,t}^{b_1} + \frac{1}{\alpha_1}X_{1,t}^{1-b_1}C_{1,t}^{b_1}\frac{1-\alpha}{\alpha}\left(\frac{C_{2,t}}{C_{1,t}}\right)^{b}\\
&= \frac{1}{\alpha_1}X_{1,t}^{1-b_1}C_{1,t}^{b_1}\left[1 + \frac{1-\alpha}{\alpha}\left(\frac{C_{2,t}}{C_{1,t}}\right)^{b}\right]\\
&= \frac{1}{\alpha\alpha_1}X_{1,t}^{1-b_1}C_{1,t}^{b_1}\left(\frac{C_t}{C_{1,t}}\right)^{b} \Rightarrow \frac{W_t}{P_{1,t}} = \frac{C_t}{1-l_t}\frac{1}{\alpha\alpha_1}\left(\frac{C_{1,t}}{C_t}\right)^{1-b}\left(\frac{X_{1,t}}{C_{1,t}}\right)^{1-b_1},
\end{aligned} \tag{F.5}$$

where the third and the last equalities make use of technological constraints (C.1), and the forth equality substitutes relative prices with quantities from equation (F.3). Equations (F.4) and (F.5) imply that

$$\nu = 1 - l_t = h_{m,t} + h_{1,t} + h_{2,t}, \tag{F.6}$$

so that we can rewrite equation (F.5) as

$$\nu\frac{W_t}{P_{1,t}} = \frac{X_{1,t}}{\alpha_1}\left(\frac{C_{1,t}}{X_{1,t}}\right)^{b_1} + \frac{P_{2,t}}{P_{1,t}}\frac{X_{2,t}}{\alpha_2}\left(\frac{C_{2,t}}{X_{2,t}}\right)^{b_2},$$

and equation (F.3) as

$$\frac{X_{1,t}}{X_{2,t}} = \left[\frac{\alpha}{1-\alpha} \frac{\alpha_1}{\alpha_2} \frac{P_{2,t}}{P_{1,t}} \frac{\left(\frac{C_{1,t}}{X_{1,t}}\right)^{b-b_1}}{\left(\frac{C_{2,t}}{X_{2,t}}\right)^{b-b_2}} \right]^{\frac{1}{1-b}}.$$

For convenience, we collect and list all the equations that describe the flexible price equilibrium:

$$\nu \frac{W_t}{P_{1,t}} = \frac{X_{1,t}}{\alpha_1} \left(\frac{C_{1,t}}{X_{1,t}}\right)^{b_1} + \frac{P_{2,t}}{P_{1,t}} \frac{X_{2,t}}{\alpha_2} \left(\frac{C_{2,t}}{X_{2,t}}\right)^{b_2}, \tag{F.7}$$

$$\frac{X_{1,t}}{X_{2,t}} = \left[\frac{\alpha}{1-\alpha} \frac{\alpha_1}{\alpha_2} \frac{P_{2,t}}{P_{1,t}} \frac{\left(\frac{C_{1,t}}{X_{1,t}}\right)^{b-b_1}}{\left(\frac{C_{2,t}}{X_{2,t}}\right)^{b-b_2}} \right]^{\frac{1}{1-b}}, \tag{F.8}$$

$$\frac{C_{1,t}}{X_{1,t}} = \left\{ \alpha_1 \left[1 + \left(\frac{1-\alpha_1}{\alpha_1} \left(\frac{P_{1,t}}{W_t} \right)^{b_1} \right)^{\frac{1}{1-b_1}} \right] \right\}^{\frac{1}{b_1}}, \tag{F.9}$$

$$\frac{C_{2,t}}{X_{2,t}} = \left\{ \alpha_2 \left[1 + \left(\frac{1-\alpha_2}{\alpha_2} \left(\frac{P_{2,t}}{P_{1,t}} \frac{P_{1,t}}{W_t} \right)^{b_2} \right)^{\frac{1}{1-b_2}} \right] \right\}^{\frac{1}{b_2}}, \tag{F.10}$$

$$h_{1,t} = \left(\frac{1-\alpha_1}{\alpha_1} \frac{P_{1,t}}{W_t} \right)^{\frac{1}{1-b_1}} X_{1,t}, \tag{F.11}$$

$$h_{2,t} = \left(\frac{1-\alpha_2}{\alpha_2} \frac{P_{2,t}}{P_{1,t}} \frac{P_{1,t}}{W_t} \right)^{\frac{1}{1-b_1}} X_{2,t}, \tag{F.12}$$

$$l_t = 1 - \nu, \tag{F.13}$$

$$h_{m,t} = 1 - l_t - h_{1,t} - h_{2,t}, \tag{F.14}$$

$$C_t = \left[\alpha C_{1,t}^b + (1-\alpha) C_{2,t}^b\right]^{\frac{1}{b}}. \tag{F.15}$$

The first two equations, (F.7) and (F.8), stand for the real value of non-leisure time, which equalizes total real income expressed in terms of good 1, and the optimal expenditure ratio across sectors, respectively. Similar to a conventional two-sector model, they suffice to determine optimal real expenditures in the two sectors, $X_{1,t}$ and $X_{2,t}$ when the relative importance of expenditures in consumption activities, dictated by equations (F.9) and (F.10), are accounted for. The other equations determine the seven remaining variables, $C_{1,t}$, $C_{2,t}$, $h_{1,t}$, $h_{2,t}$, l_t, $h_{m,t}$, and C_t, given the two relevant relative prices. Some notable cases are nested.

Appendix F.1.1. Baseline New-Keynesian two-sector model

If $\alpha_1 = \alpha_2 = 1$, no time is required for consumption activities, i.e., $h_{1,t} = h_{2,t} = 0$, $X_{1,t} = C_{1,t}$, and $X_{2,t} = C_{2,t}$, and the model reduces to a canonical two-sector model, so that:

$$\begin{aligned} X_{1,t} &= \frac{\nu Z_{1,t}}{1 + \left(\frac{(1-\alpha)Z_{2,t}}{\alpha Z_{1,t}}\right)^{\frac{1}{1-b}} \frac{Z_{1,t}}{Z_{2,t}}}, \\ X_{2,t} &= \left(\frac{(1-\alpha)Z_{2,t}}{\alpha Z_{1,t}}\right)^{\frac{1}{1-b}} \frac{\nu Z_{1,t}}{1 + \left(\frac{(1-\alpha)Z_{2,t}}{\alpha Z_{1,t}}\right)^{\frac{1}{1-b}} \frac{Z_{1,t}}{Z_{2,t}}}. \end{aligned} \tag{F.16}$$

In absence of time use in consumption activities, the value of non-leisure time expressed in units of good 1, $\nu Z_{1,t}$, coincides with real income, which equalizes total consumption expenditures. Expenditure shares of goods 1 and 2 reads as

$$\begin{aligned} \gamma_{1,t} &\equiv \frac{X_1}{\nu Z_{1,t}} = \frac{1}{1 + \left(\frac{(1-\alpha)Z_{2,t}}{\alpha Z_{1,t}}\right)^{\frac{1}{1-b}} \frac{Z_{1,t}}{Z_{2,t}}}, \\ \gamma_{2,t} &\equiv \frac{Z_{1,t}}{Z_{2,t}} \frac{X_2}{\nu Z_{1,t}} = \frac{\left(\frac{(1-\alpha)Z_{2,t}}{\alpha Z_{1,t}}\right)^{\frac{1}{1-b}} \frac{Z_{1,t}}{Z_{2,t}}}{1 + \left(\frac{(1-\alpha)Z_{2,t}}{\alpha Z_{1,t}}\right)^{\frac{1}{1-b}} \frac{Z_{1,t}}{Z_{2,t}}}, \end{aligned} \tag{F.17}$$

respectively. Expenditure shares depend on relative prices and reduce to α and $1-\alpha$ for the simpler Cobb-Douglas case, $b = 0$.

In the more general case, consumption requires time and the value of non-leisure time, $\nu Z_{1,t}$ reflects both the market value of consumption expenditures and the opportunity cost of time spent in consumption activities.

Appendix F.1.2. Baseline home production model

If $\alpha_1 = 1$ and $\alpha_2 = 0$, then $h_{1,t} = 0$ and $X_{2,t} = 0$. Hence $C_{1,t} = X_{1,t}$ and $C_{2,t} = h_{2,t}$ i.e, good 1 is a market good and good 2 is a home produced good as in Benhabib et al. (1991), Gnocchi et al. (2016) and Cacciatore et al. (2024). Equations (C.4), (C.6) and (C.9) imply

$$\frac{U_l(C_t, l_t)}{U_C(C_t, l_t)} \frac{1}{\alpha} \left(\frac{X_{1,t}}{C_t} \right)^{1-b} = \frac{W_t}{P_{1,t}}, \tag{F.18}$$

whereas it follows from equations (C.5) and (C.8) that

$$\frac{U_l(C_t, l_t)}{U_C(C_t, l_t)} \frac{1}{1-\alpha} \left(\frac{h_{2,t}}{C_t} \right)^{1-b} = 1. \tag{F.19}$$

Using the fact that

$$\frac{U_l(C_t, l_t)}{U_C(C_t, l_t)} = \frac{(1-\nu)C_t}{\nu l_t}, \tag{F.20}$$

one can describe the flexible price equilibrium with equations

$$Z_{1,t} h_{m,t} = X_{1,t}, \tag{F.21}$$

$$\frac{1-\alpha}{\alpha Z_{1,t}} = \left(\frac{h_{2,t}}{X_{1,t}} \right)^{1-b}, \tag{F.22}$$

$$\nu l_t = \frac{(1-\nu)C_t}{\alpha Z_{1,t}} \left(\frac{X_{1,t}}{C_t} \right)^{1-b}, \tag{F.23}$$

together with (F.14)-(F.15). The value of non-leisure time can be found by making use of the resource constraint and the remaining first-order conditions,

$$\begin{aligned} &Z_{1,t}(h_{m,t} + h_{2,t}) = X_{1,t} + \frac{1-\alpha}{\alpha} X_{1,t}^{1-b} h_{2,t}^b = \frac{1}{\alpha} X_{1,t}^{1-b} \left[\alpha X_{1,t}^b + (1-\alpha) h_{2,t}^b \right] = \\ &= \frac{1}{\alpha} X_{1,t}^{1-b} C_t^b \Rightarrow Z_{1,t} = \frac{C_t}{1-l_t} \frac{1}{\alpha} \left(\frac{C_{1,t}}{C_t} \right)^{1-b}, \end{aligned} \tag{F.24}$$

and, together with equation (F.23), it again implies

$$\nu = 1 - l_t = h_{m,t} + h_{1,t} + h_{2,t},$$

so that equation (F.24) can be rewritten as

$$\nu Z_{1,t} = \frac{X_{1,t}}{\alpha}\left(\frac{C_t}{X_{1,t}}\right)^b = \frac{X_{1,t}}{\alpha}\left[\alpha + (1-\alpha)\left(\frac{h_{2,t}}{X_{1,t}}\right)^b\right] =$$
$$= X_{1,t}\left[1 + \frac{1-\alpha}{\alpha}\left(\frac{1-\alpha}{\alpha Z_{1,t}}\right)^{\frac{b}{1-b}}\right]. \tag{F.25}$$

One can finally solve for the equilibrium:

$$C_{1,t} = X_{1,t} = \frac{\nu Z_{1,t}}{1 + \left(\frac{1-\alpha}{\alpha Z_{1,t}^b}\right)^{\frac{1}{1-b}}}, \tag{F.26}$$

$$C_{2,t} = h_{2,t} = \left(\frac{1-\alpha}{\alpha Z_{1,t}^b}\right)^{\frac{1}{1-b}} \frac{\nu Z_{1,t}}{1 + \left(\frac{1-\alpha}{\alpha Z_{1,t}^b}\right)^{\frac{1}{1-b}}}, \tag{F.27}$$

$$h_{m,t} = \frac{\nu}{1 + \left(\frac{1-\alpha}{\alpha Z_{1,t}^b}\right)^{\frac{1}{1-b}}}, \tag{F.28}$$

$$l_t = 1 - \nu, \tag{F.29}$$

$$C_t = \left(\alpha X_{1,t}^b + (1-\alpha) h_{2,t}^b\right)^{\frac{1}{b}}, \tag{F.30}$$

and $h_{1,t} = X_{1,t} = 0$.

Appendix F.2. Zero-inflation steady state and parametrization

The zero inflation steady-state follows by imposing steady-state values for shocks i.e., $Z_{1,t} = Z_1$ and $Z_{2,t} = Z_2$, in the system of equations that describe flexible-price equilibrium. We denote the steady-state value of variables by omitting their time subscripts.

Parameters α, α_1, α_2, and ν and the steady-state productivity of market hours, Z_1 and Z_2, are calibrated so as to implement six steady-state targets: $T_1 \equiv h_1$, $T_2 \equiv h_2$, $T_3 \equiv h_m$, $T_4 \equiv X_1/h_1$, $T_5 \equiv X_2/h_2$, and $T_6 \equiv s/q$. Remaining parameters are calibrated externally to match microeconomic estimates, or they are varied over their admissible range to perform comparative dynamics. Targets directly imply

$$X_1 = T_4 T_1 \quad \text{and} \quad X_2 = T_5 T_2,$$

whereas it follows from resource constraints that

$$l = 1 - T_1 - T_2 - T_3 \quad \text{and} \quad Z_2 = \frac{T_1 T_4}{T_3 T_6} + \frac{T_5 T_2}{T_3},$$

so that

$$Z_1 = T_6 Z_2 \quad \text{and} \quad \nu = T_1 + T_2 + T_3$$

from equations (F.1) and (F.6). First order conditions (F.11) and (F.12) are used to determine α_1 and α_2:

$$\alpha_1 = \frac{1}{1 + Z_1 T_4^{b_1 - 1}}, \qquad \alpha_2 = \frac{1}{1 + Z_2 T_5^{b_2 - 1}}, \tag{F.31}$$

and C_1 and C_2 immediately follow from technological constraints (C.1). Finally, one can recover

$$\alpha = \frac{C_2^{b-1} \alpha_2 \left(\frac{X_2}{C_2}\right)^{b_2 - 1}}{T_6 C_1^{b-1} \alpha_1 \left(\frac{X_1}{C_1}\right)^{b_1 - 1} + C_2^{b-1} \alpha_2 \left(\frac{X_2}{C_2}\right)^{b_2 - 1}} \tag{F.32}$$

from equation (F.8), and C from technological constraints (C.1).

Appendix G. Alternative Imputation Procedures and Robustness

Appendix G.1. Matching CEX and ATUS

Although the ATUS has a much smaller sample size—approximately 7,550 observations per year compared to about 18,230 in the CEX, after imposing our sample restrictions—both surveys represent approximately the same number of weighted observations each year. Moreover, the composition of the two samples is relatively similar. Table G.4 presents summary statistics for key demographic variables across both surveys. For age and number of children we report mean values; for all other variables, we report the share of respondents with each characteristic. The distributions are broadly comparable between the ATUS and CEX samples.

Appendix G.2. Alternative Imputation Procedures

As robustness exercises, we compare our baseline Group Mean procedure with Tobit and Heckman-type imputations commonly used in settings with many zero time-use observations.

Appendix G.2.1. Tobit Imputation

Our first alternative specification models time allocation as a corner-solution problem:

$$\tau_{i,j,t} = \max\left\{0, z_{i,t}' \beta_j + \delta_t + \varepsilon_{i,j,t}\right\},$$

Variable (mean)	CEX	ATUS
Age	45.19	44.45
Male	0.48	0.50
Black	0.13	0.12
Married	0.58	0.63
Working	0.82	0.78
Number of children	0.79	0.81
Less than high school	0.11	0.10
High-school graduates	0.23	0.30
Some college and above	0.65	0.60

Table G.4: Summary Statistics in CEX and ATUS Samples, 2003–2019

where $z_{i,t}$ includes demographic characteristics common to CEX and ATUS, δ_t denotes year fixed effects, and $\varepsilon_{i,j,t} \sim N(0, \sigma_j^2)$.

Appendix G.2.2. Heckman-Type Imputation

Our second alternative follows a two-step Heckman-type procedure similar to Mukoyama et al. (2018). In the first step, we estimate the probability that household i allocates positive time to activity j:

$$p_{i,j,t} = \beta_0 + \beta_1 Z_{i,t} + \varepsilon_{i,j,t}.$$

In the second step, we estimate time allocation conditional on participation:

$$\tau_{i,j,t} = \gamma_0 + \gamma_1 Z_{i,t} + \gamma_2 \lambda(\hat{p}_{i,j,t}) + \mu_{i,j,t},$$

where $\lambda(\hat{p}_{i,j,t})$ is the inverse Mills ratio evaluated at the predicted participation probability.

Appendix G.3. Validation of Imputed Time Use

Figures G.4–G.6 compare annual averages of actual ATUS weekly hours with imputed hours across all core activities and consumption bundles for the three imputation methods. Group Mean imputation tracks the observed time series closely across all categories, while Tobit and Heckman imputations produce similar qualitative patterns with somewhat larger deviations for activities with relatively low average hours. Overall, the three procedures deliver comparable time-use dynamics and similar elasticity estimates, supporting the robustness of our findings. These comparisons serve as validation exercises following Mukoyama et al. (2018) but are distinct from the elasticity estimation, which exploits cross-sectional variation in the merged CEX–ATUS dataset.

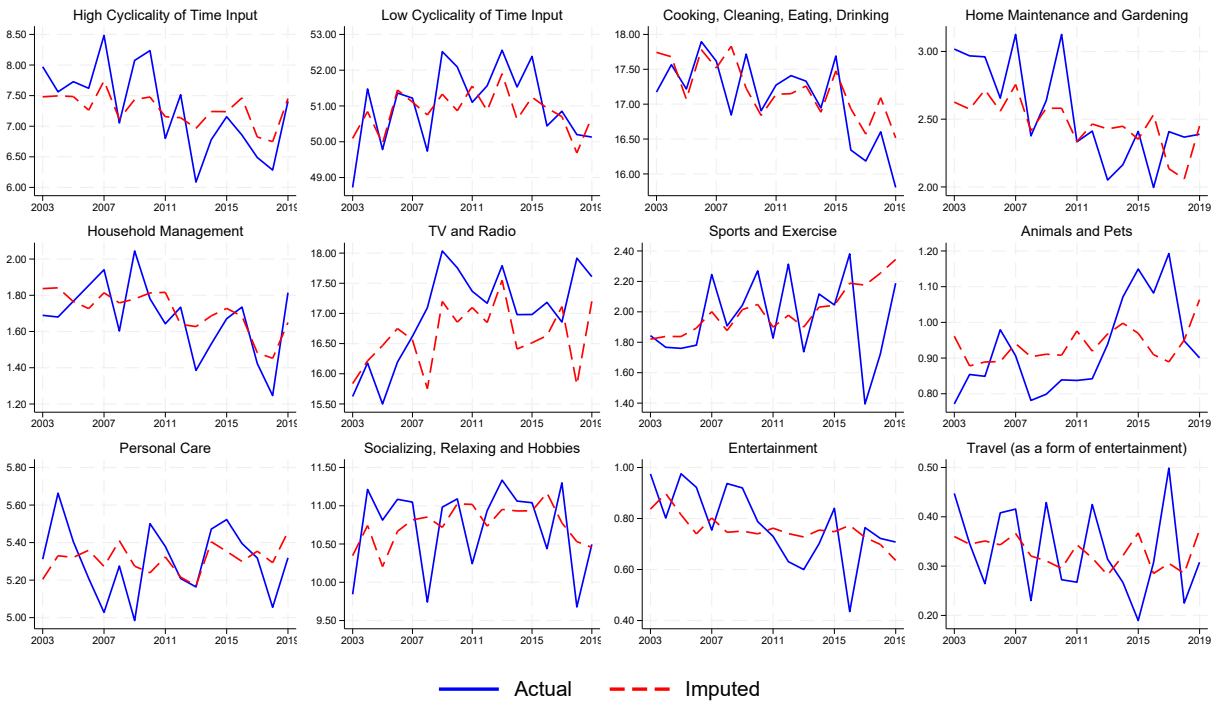


Figure G.4: Group Mean Imputation: Comparison of actual ATUS and imputed weekly hours, 2003–2019. Observations are weighted by ATUS sample weights.

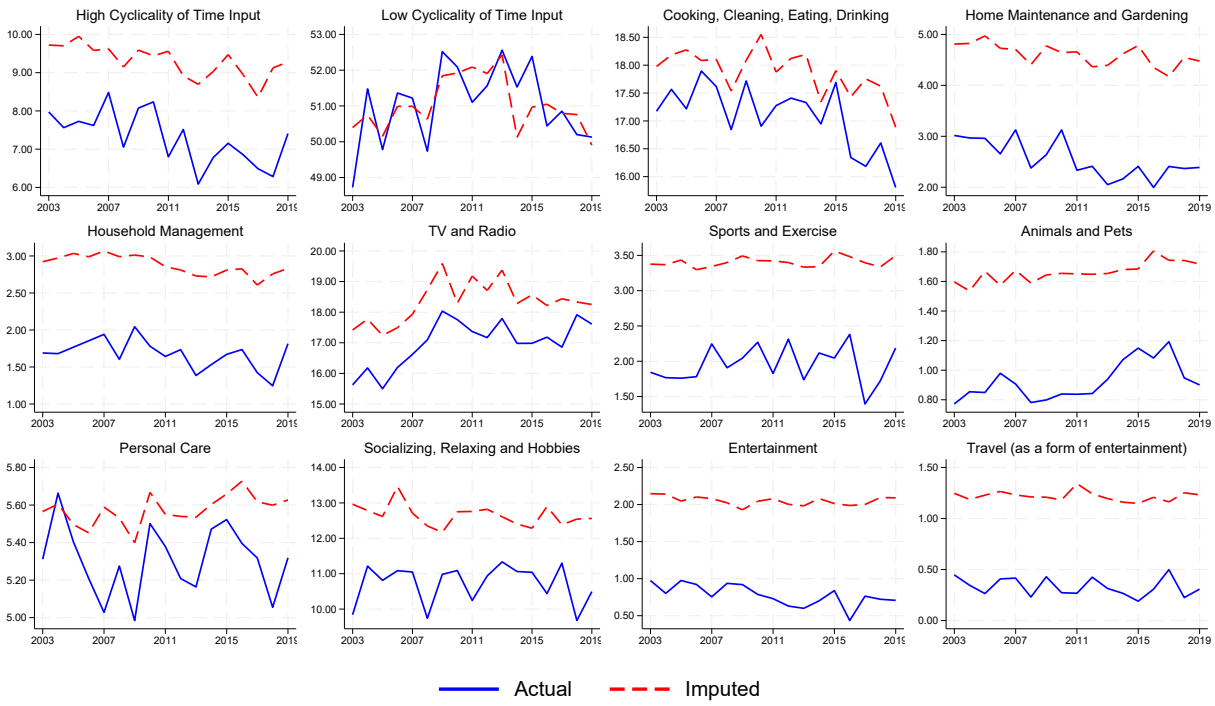


Figure G.5: Tobit Imputation: Comparison of actual ATUS and imputed weekly hours, 2003–2019. Observations are weighted by ATUS sample weights.

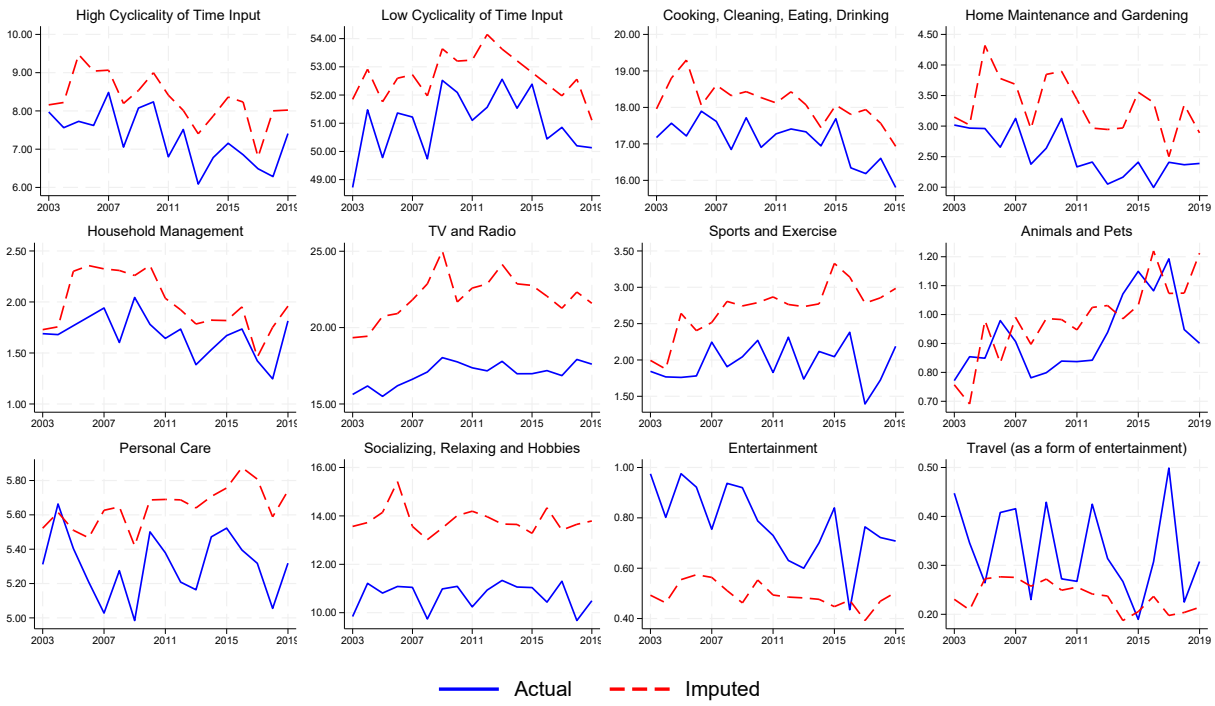


Figure G.6: Heckman Imputation: Comparison of actual ATUS and imputed weekly hours, 2003–2019. Observations are weighted by ATUS sample weights.

Appendix G.4. Elasticity Estimates Across Imputation Methods

Table G.5 presents elasticity estimates using all three imputation methods. The results are remarkably stable across specifications: the ranking of activities by elasticity is preserved, and the magnitudes are quantitatively similar across procedures. Activities with highly cyclical time inputs consistently display elasticities around 3, while activities with weakly cyclical time inputs display substantially lower elasticities. Likewise, at the bundle level the elasticity of substitution is systematically larger for the high time-cyclicality bundle than for the low time-cyclicality bundle under every imputation method: 3.13 versus 1.62 under group mean, 2.97 versus 1.47 under Tobit, and 2.92 versus 1.56 under Heckman.

Appendix H. Price Stickiness across Bundles: Data and Methodology

This appendix documents the data and methodology underlying the bundle-level price stickiness estimates in Section 4.2, and presents the full set of robustness exercises across alternative samples and aggregation measures.

Activity	Time Cyclicality ε^j (1)	Elasticity of Substitution $(1-b_j)^{-1}$		
		Group Mean (2)	Tobit (3)	Heckman (4)
Travel (as a form of entertainment)	0.48	3.47 (0.07)	3.61 (0.04)	3.40 (0.05)
Home Maintenance and Gardening	0.53	3.42 (0.05)	2.95 (0.03)	3.10 (0.04)
Household Management	0.43	3.40 (0.07)	3.42 (0.06)	3.18 (0.06)
Sports and Exercise	0.52	3.08 (0.06)	3.19 (0.04)	2.91 (0.05)
Personal Care	-0.07	2.51 (0.02)	2.31 (0.02)	2.39 (0.02)
Entertainment	0.53	2.35 (0.06)	2.62 (0.03)	2.32 (0.04)
Animals and Pets	0.28	2.00 (0.04)	2.00 (0.03)	1.91 (0.03)
Socializing, Relaxing and Hobbies	0.39	1.81 (0.02)	1.73 (0.02)	1.79 (0.02)
TV, Radio, Music	0.35	1.52 (0.01)	1.40 (0.01)	1.48 (0.01)
Cooking, Cleaning, Eating, Drinking	0.23	1.41 (0.01)	1.26 (0.01)	1.27 (0.01)

Table G.5: Elasticity of Substitution across Imputation Methods. Columns (2)–(4) report estimated elasticities of substitution $(1-b_j)^{-1}$ for each activity under three imputation procedures: group mean (Column 2, reproduced from Table 5), Tobit (Column 3), and Heckman (Column 4). Column (1) reports time cyclicality for each activity (see Table 3). All specifications use total consumption expenditures and educational attainment as instruments. Standard errors are reported in parentheses. Activities are ordered as in Table 5.

Appendix H.1. Data

We use price duration statistics computed by Nakamura and Steinsson (2008) and Montag and Villar Vallenas (2025) from the BLS CPI Research Database, a confidential dataset maintained by the Bureau of Labor Statistics containing product-level monthly prices underlying the U.S. CPI. The database covers the non-shelter component, which accounts for approximately 70 percent of consumer expenditures. Prices are observed at the level of Entry Level Items (ELIs), the most granular product categories in the publicly identifiable CPI classification, each corresponding to a narrowly defined category of household purchases such as men's shirts, fresh whole milk, household paper products, or airline fares.

We use ELI-level estimates of monthly regular price duration averaged over three sample periods: 1978–2019 (our benchmark, based on Montag and Villar Vallenas 2025), 1978–August 2024 (the extended Montag and Villar Vallenas 2025 sample, including the pandemic period), and 1998–2005 (Nakamura and Steinsson 2008). These ELI-level durations are combined with CPI expenditure weights to construct the weighted statistics reported throughout. We focus on regular price changes (excluding sales), since temporary sales and promotions reflect different pricing mechanisms than underlying price adjustments.

Appendix H.2. Methodology: From ELIs to Activities to Bundles

We compute price duration for the high and low time-cyclicality bundles in three steps: (i) mapping each ELI to one of the ten consumption activities defined in our empirical anal-

ysis, (ii) aggregating ELI-level price-change frequencies to the activity level, separately for activity-specific and proportional expenditures, and (iii) aggregating activity-level statistics to the bundle level using expenditure shares.

Step 1: ELI-to-NIPA-to-Activity Mapping. We map all ELIs to their corresponding NIPA items (third level of aggregation) through a one-to-one correspondence: each ELI is uniquely assigned to exactly one NIPA item, and each NIPA item to its corresponding consumption activity.

Step 2: Distinguishing Expenditure Types. For each activity, we distinguish between activity-specific expenditures (uniquely assigned to a single activity) and proportional expenditures (allocated across multiple activities based on average weekly hours).

Activity-Specific Price Duration. For each activity j, the price duration of activity-specific expenditures is the weighted average across the k ELIs uniquely assigned to j:

$$d_j^{as} = \frac{\sum_{i=1}^{k} ELI_i^{as} w_i^{as}}{W_j^{as}}, \tag{H.1}$$

where w_i^{as} is the CPI expenditure weight on ELI i and $W_j^{as} \equiv \sum_{i=1}^{k} w_i^{as}$.

Proportional Price Duration. For proportional expenditures, each ELI is weighted by its CPI weight and by the time-share of activity j relative to all activities sharing the same proportional expenditures:

$$d_j^{p} = \frac{\sum_{i=1}^{l} ELI_i^{p} w_i^{p} \cdot \frac{h_j}{h^p}}{W_j^{p} \cdot \frac{h_j}{h^p}}, \tag{H.2}$$

where $W_j^p \equiv \sum_{i=1}^{l} w_i^p$, h_j is the average weekly hours spent on activity j, and h^p is the average weekly hours spent on all activities sharing the proportional expenditures of j.

Activity-Level Price Duration. The price duration for the full consumption bundle of activity j, combining activity-specific and proportional expenditures, is:

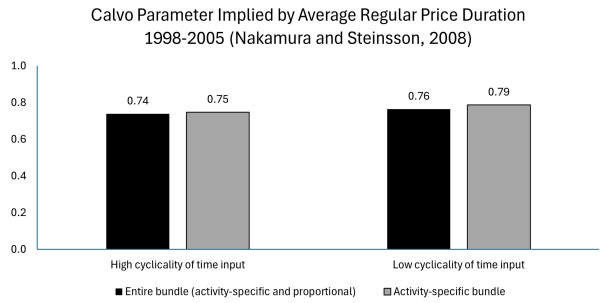
$$d_j = \frac{d_j^{as} W_j^{as} + d_j^{p} W_j^{p} \cdot \frac{h_j}{h^p}}{W_j^{as} + W_j^{p} \cdot \frac{h_j}{h^p}}. \tag{H.3}$$

Step 3: Bundle-Level Aggregation. For the high and low time-cyclicality bundles, we apply the same aggregation across the activities in each bundle, weighting each activity's total price duration d_j by its expenditure share within the bundle.

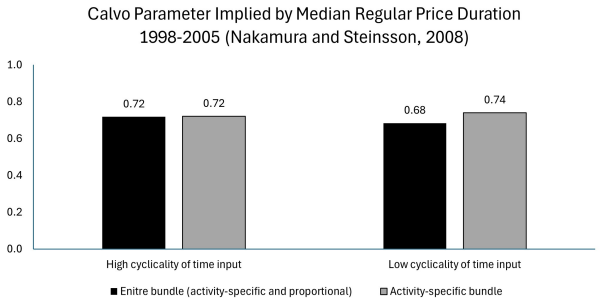
Appendix H.3. Bundle-Level Robustness

Figure H.7 reports implied Calvo parameters for the high and low time-cyclicality bundles across all three samples and both aggregation measures (weighted mean and weighted median). The pattern documented in the main text is robust across samples and measures: the high time-cyclicality bundle exhibits marginally lower Calvo parameters than the low time-cyclicality bundle in the two Montag and Villar samples, with a slightly reversed but comparable pattern in the shorter, post-Volcker Nakamura and Steinsson sample. In all cases the cross-bundle difference is small, ranging from 0.02 to 0.07 across the six panels.

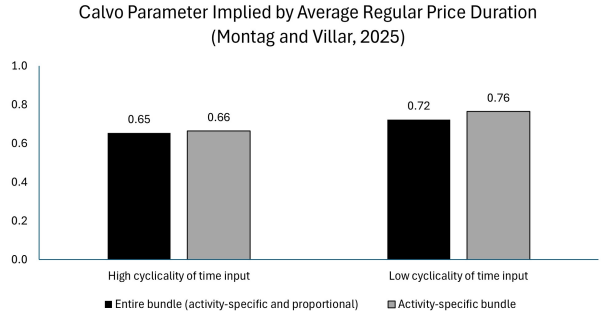
Tables H.6 and H.7 report the underlying price-change frequencies, implied price durations, and Calvo parameters for the high and low time-cyclicality bundles respectively, separately for the entire consumption bundle and for activity-specific expenditures only.



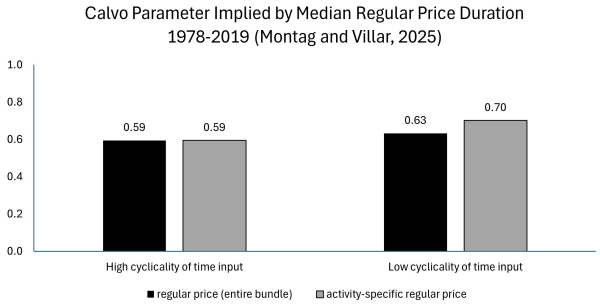
(a) Mean (Nakamura & Steinsson 1998–2005)



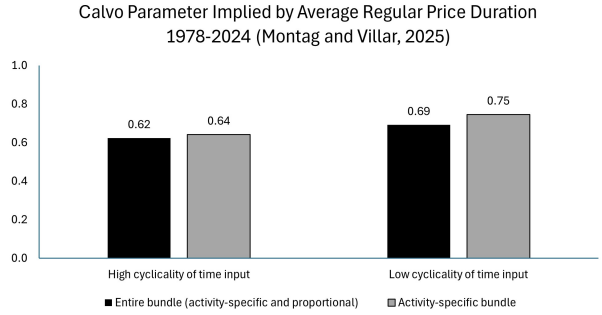
(b) Median (Nakamura & Steinsson 1998–2005)



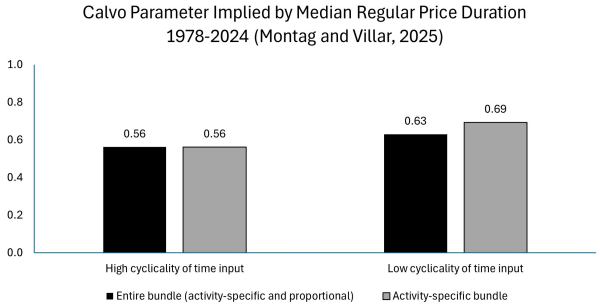
(c) Mean (Montag & Villar 1978–2019)



(d) Median (Montag & Villar 1978–2019)



(e) Mean (Montag & Villar 1978–2024)



(f) Median (Montag & Villar 1978–2024)

Figure H.7: **Bundle-level price stickiness: robustness across samples and measures.** Implied quarterly Calvo parameters for the high and low time-cyclicality bundles, based on weighted mean (left column) and weighted median (right column) regular price durations. Estimates use Nakamura and Steinsson (2008) for 1998–2005 and Montag and Villar Vallenas (2025) for 1978–2019 and 1978–2024.

	Entire bundle						**Activity-specific**					
	Mean			Median			Mean			Median		
Data Source and Period	Price Freq.	Duration (months)	Calvo Param.	Price Freq.	Duration (months)	Calvo Param.	Price Freq.	Duration (months)	Calvo Param.	Price Freq.	Duration (months)	Calvo Param.
Nakamura and Steinsson (1998–2005)	23.88	11.49	0.74	8.97	10.64	0.72	19.74	11.90	0.75	8.88	10.75	0.72
Montag and Villar (1978–2019)	24.30	8.66	0.65	12.65	7.40	0.59	20.30	8.93	0.66	12.65	7.40	0.59
Montag and Villar (1978–2024)	25.71	7.97	0.62	13.59	6.85	0.56	21.85	8.38	0.64	13.59	6.85	0.56

Table H.6: **Price duration statistics: high time-cyclicality bundle.** Weighted price-change frequencies, implied price durations, and Calvo parameters across samples and aggregation measures.

	Entire bundle						Activity-specific					
	Mean			Median			Mean			Median		
Data Source and Period	Price Freq.	Duration (months)	Calvo Param.	Price Freq.	Duration (months)	Calvo Param.	Price Freq.	Duration (months)	Calvo Param.	Price Freq.	Duration (months)	Calvo Param.
Nakamura and Steinsson (1998–2005)	21.24	12.75	0.76	10.00	9.49	0.68	11.26	14.11	0.79	8.30	11.55	0.74
Montag and Villar (1978–2019)	21.89	10.85	0.72	11.53	8.16	0.63	12.38	12.74	0.76	9.47	10.05	0.70
Montag and Villar (1978–2024)	22.48	9.74	0.69	11.61	8.11	0.63	12.66	11.82	0.75	9.72	9.78	0.69

Table H.7: **Price duration statistics: low time-cyclicality bundle.** Weighted price-change frequencies, implied price durations, and Calvo parameters across samples and aggregation measures.