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STICKY CONSUMPTION AND WEALTH EFFECTS IN SWITZERLAND

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When assessing the effect of changes in wealth on household expenditures, most empirical studies have used cointegration-based approaches. These approaches rely on the existence of a stable long-run relationship among consumption, wealth, and income. However, in Switzerland no such relationship seems to be present after 2001. Motivated by this issue, this paper applies a recently suggested approach to estimating long-run wealth effects on consumption that does not rely on cointegration. This new approach relies on sticky consumption growth, which can be motivated by consumption habits or sticky expectations. In both cases, long-run wealth effects are the result of short-run reactions of households to changes in wealth which become long-lasting. Using this methodology, the estimated wealth effects on consumption in Switzerland are larger than suggested by cointegration-based estimates. Furthermore, the results show that there seems to be a remarkably high degree of consumption stickiness in Switzerland.

JEL Codes: D12, E21, E44, C22

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1. INTRODUCTION

Changes in wealth can affect expenditure of consumers in both the short run and the long run. When assessing such effects—that is, the estimation of marginal propensities to consume (MPC) out of wealth—most empirical studies have used cointegration-based approaches.[1] These approaches rely on the existence of a stable long-run relationship among consumption, wealth, and income, which is motivated by linearizing and rewriting the intertemporal budget constraint of households. The resulting cointegrating residual, called *cay*, can be interpreted as an approximation of the consumption-to-wealth ratio. It is a function of the net present value of future net returns on aggregate wealth and future consumption growth. If these two variables are assumed to be stationary, the cay residual will be

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[1]See, for example, Lettau and Ludvigson (2001, 2004), Benjamin *et al.* (2004), Hamburg *et al.* (2008), Sousa (2010), or Fisher Voss (2004).

stationary and consumption, wealth, and income will be cointegrated. The MPC out of wealth is then given by a transformation of the coefficient on wealth in the cointegrating vector of these three variables. Internationally, this MPC out of wealth usually lies between 3 and 7 cents. A good, broad survey of the literature on empirical evidence for wealth effects on consumption has been carried out by Cooper and Dynan (2016) for studies using macro data and those using micro data.

For Switzerland, the question of how changes in wealth affect household expenditures is particularly interesting today. Uptrends in stock market prices and the parallel rise in real estate prices have led to a strong increase in Swiss household wealth over the past few years. From 2004 to 2014, per capita wealth rose by almost 40 percent. Despite the potential importance of wealth effects for Switzerland, hardly any studies have investigated this question. Only two studies, both cointegration-based, have appeared so far. The first one (Schmid 2013) estimated that a 1 percent increase in wealth increases consumption expenditures by 0.42 percent in the long run. This would correspond to a MPC out of wealth of approximately 5.7 Swiss centime, suggesting that a one-franc increase in Swiss household wealth would cause an increase of 5.7 Swiss centime in consumption expenditures in the long run. The second study (Galli 2017) updated these estimates based on more recent and revised data. The results for the entire sample period, 1980–2012, suggested that wealth effects are hardly present in Switzerland. However, this result turned out to be largely driven by the most recent past, during which consumption did not respond to several major changes in wealth. Until 2001, in contrast, consumption, wealth, and income were found to be cointegrated with an MPC out of wealth that was in the range of 2.0–4.8 Swiss centime.

This unstable outcome may be due to several fragility issues related to the cointegration-based approach to estimating wealth effects. Motivated by the drawbacks of the cointegration approach, Slacalek (2009) and Carroll *et al*. (2011a) recently proposed an alternative approach to estimating long-run wealth effects on consumption that does not require the existence of a stable long-run relationship. Instead, the method relies on sticky consumption growth, which can be motivated by consumption habits or sticky expectations. In both cases, the long-run wealth effect is then the accumulation of short-run reactions of households to a change in wealth. The higher the degree of stickiness, the longer is the period over which a change in wealth affects household expenditures. International empirical evidence of sticky consumption growth can be found in, for example, Carroll *et al*. (2011b). Compared to the cointegration method, the consumption stickiness–based approach to estimating wealth effects has the advantage of being much more robust to changes in the underlying parameters, including expected income growth and demographics, as Carroll *et al*. (2011a) have argued. Furthermore, in contrast to the cointegration-based approach, the estimation of separate financial and housing wealth effects is straightforward.

This paper applies this alternative, consumption stickiness–based approach to Swiss data and investigates how the results compare to those obtained in cointegration-based studies. Furthermore, by distinguishing between financial and non-financial wealth, this paper also tries to shed light on how the recent strong rise in real estate prices and housing wealth could affect personal consumption expenditures.

Possible differences in the strength of households' reaction to changes in financial wealth and changes in housing wealth have previously been discussed in Galli (2017).

The analysis is performed within a Bayesian framework. On the one hand, this allows the inclusion of theoretically or empirically motivated beliefs on the degree of consumption stickiness and the magnitude of wealth effects through the choice of priors. On the other, Bayesian estimation allows to easily obtain distributions for the estimated wealth effects, despite the non-linearity of the corresponding parameters. This permits a more detailed analysis of the degree and symmetry of uncertainty surrounding the estimated MPCs. Furthermore, compared to maximum likelihood, it also avoids potential convergence and starting value issues.

The obtained results reveal four features. First, there seems to be a remarkably high degree of consumption stickiness in Switzerland. Viewed in a sticky expectations context, only approximately half of the households update their expectations and optimize their consumption behavior in a given year. Therefore, consumption growth is quite persistent even on an annual basis.

Second, wealth effects in Switzerland are substantially larger (between 5.7 and 7.4 Swiss centime at the median) than indicated by the cointegration-based results of Galli (2017), which suggested—driven by the data sample after 2001—that wealth effects are hardly present. Thus, changes in wealth do have a long-run effect on consumption in Switzerland, but a stable level relationship between consumption and wealth no longer seems to exist. This also implies the absence of error-correction mechanisms.

Third, the results for separate financial and housing wealth effects suggest that the median one-period MPC is somewhat higher out of financial wealth than out of total wealth, and the one out of housing wealth is somewhat smaller. In addition, there is a much higher degree of uncertainty surrounding the latter.

Fourth, a comparison with estimates for other countries reveals that the degree of stickiness in Swiss private consumption is among the highest. Furthermore, in terms of wealth effects, the short-run wealth effect is rather small compared to other countries. However, given the high degree of stickiness of Swiss private consumption, changes in wealth in a given period have an effect on consumption not only in the next period but also, to a large extent, in upcoming periods. Thus, the accumulated long-run effect lies somewhere in the middle of the international results. The same applies to the separate financial and housing wealth effects.

The remainder of this paper is organized as follows. Section 2 provides an overview of the theoretical motivation behind the stickiness-based approach to estimating wealth effects. Section 3 describes the estimation strategy and the data. Section 4 presents the empirical results for the case of Switzerland and shows how these results compare to international results. Section 5 concludes the paper.

2. Theoretical Motivation

Wealth effects are often estimated using cointegration-based approaches, which rely on the existence of a stable relationship among consumption, wealth, and income. In the Swiss case, however, no such relationship seems to have been present since 2001 (see Galli 2017). Several studies, such as Slacalek (2009) and Carroll *et al.* (2011a), have shown that the cointegration approach to estimating wealth effects is generally fraught with fragility issues related to changes in the fundamentals of the economy, such as the long-run growth rate, the long-run interest rate, tax and pension schemes, social security generosity, or demographics, which affect the equilibrium among consumption, wealth, and income and thus the cointegrating vector. Labor frictions and income uncertainty may also affect the results. The authors further argued that due to changes in factors that affect the economy, one would need very long data series to obtain reliable estimates of the cointegrating vector.

Muellbauer (2007) and Aron *et al.* (2008) issued related critiques. They also questioned the reliability of estimated wealth effects, because estimation results are often affected by (omitted) changes in fundamentals. For instance, when estimating both housing wealth effects and total wealth effects, controls for common drivers of house prices and consumption, such as income growth expectations, interest rates, credit supply conditions, indicators of income uncertainty, or even income itself, are often omitted. The authors argued, in particular, that when not controlling for the direct effect of credit liberalization, housing wealth effects can be over-estimated because "a major part of the rise of the consumption to income ratio was due to easing of credit availability" (p. 28).[2]

Aron *et al.* (2011) showed that when controlling for such changes in credit conditions and additionally using a more disaggregate wealth vector, the relationship among consumption, wealth, and income can become stable over time again and the cointegration approach remains valid. However, this is not the case for Switzerland.

Motivated by the above-mentioned issues regarding the effect of structural changes on cointegration-based estimates for wealth effects, Slacalek (2009) and Carroll *et al.* (2011a) recently proposed an approach to estimating wealth effects on consumption that does not require the existence of a stable long-run relationship. Instead, the method assumes sticky consumption growth, which can be motivated by consumption habits or sticky expectations. In both cases, the long-run wealth effect is then the accumulation of households' short-run reactions to changes in wealth.

2.1. *General Model of Sticky Consumption Growth*

Theoretically, as described in Sommer (2007), such consumption stickiness can be motivated in two ways: consumption habits or sticky expectations. In a habit-formation model, households maximize utility as follows:

$$\max_{C_t} \sum_{t=0}^{\infty} B^t U[C_t - \mathcal{X} C_{t-1}] = \max_{C_t} \sum_{t=0}^{\infty} B^t U[(1-\mathcal{X})C_t + \mathcal{X}\Delta C_t] \tag{1}$$

[2]In principle, this omitted-variable problem may arise not only when using cointegration-based approaches to estimating wealth effects but also in general. However, regime changes can have a lager influence in the cointegration context because they may lead to a violation of the underlying assumption of a stable relationship among consumption, wealth, and income.

$$\text{s.t. } A_{t+1} = (1+r)(A_t + Y_t - C_t), \tag{2}$$

where B is a discount factor, $\mathcal{X}$ is the degree of stickiness in consumption, $1 + r$ is the gross interest rate, A_t is total wealth, Y_t is income, and C_t is the level of consumption. In this framework, utility comes from both the level of consumption in period t and from the change in consumption between t−1 and t. Thus, in a habit-formation context, habits are irrelevant if $\mathcal{X} = 0$; in this case, utility only comes from the level of consumption in period t. At the other extreme, in case of $\mathcal{X} = 1$, the level of consumption itself is not relevant, and utility is only derived from increases in the level of consumption.

Assuming a standard Constant Relative Risk Aversion (CRRA) utility function, the optimization problem of the household is given by

$$\max E_t \left[\sum_{t=0}^{T} B^t \frac{X_t^{1-\sigma}}{1-\sigma} \right], \tag{3}$$

where X is the utility-generating object. This yields the following well-known Euler equation:

$$E\left[(1+r)B\left(\frac{X_{t+1}}{X_t}\right)^{-\sigma} \right] = 1. \tag{4}$$

Assuming rational expectations, the expectation of utility-generating object X equals its actual realization plus an expectational error. Thus, we have

$$(1+r)B\left(\frac{X_{t+1}}{X_t}\right)^{-\sigma} = 1 + e_{t+1}, \tag{5}$$

where e_{t+1} is a mean-zero forecast error. Under rational expectations, we have $E_t[e_{t+1}] = 0$ and $Cov(e_t, e_{t+1}) = 0$. Taking logarithms and rewriting the equation yields

$$\Delta \log (X_{t+1}) = \frac{1}{\sigma}\left[\log(B) + \log(1+r)\right] - \frac{1}{\sigma}\log(1+e_{t+1}). \tag{6}$$

After replacing X_t with our utility relevant consumption term, $C_t - \mathcal{X} C_{t-1}$, we have

$$\Delta \log (C_{t+1} - \mathcal{X} C_t) = \frac{1}{\sigma}\left[\log(B) + \log(1+r)\right] - \frac{1}{\sigma}\log(1+e_{t+1}). \tag{7}$$

Following Muellbauer (1988) and Dynan (2000), the left-hand side of this equation can be approximated by $\Delta \log (C_{t+1}) - \mathcal{X}\Delta \log (C_t)$. Thus, we obtain the following approximation for the result of the dynamic optimization problem:

$$\Delta \log C_t = \mu + \mathcal{X}\Delta \log C_{t-1} + \varepsilon_t. \tag{8}$$

μ captures all constant terms, and ε_t is an error term that represents innovations to lifetime resources, as described in Sommer (2007). The equation states that the log change in aggregate consumption approximately follows an AR(1) process.

The same outcome can be obtained from a sticky expectations framework, in which we can rewrite aggregate consumption as follows:

$$C_t = \int_0^1 c_{t,i} di = \mathcal{X} C_{t-1} + (1-\mathcal{X}) \int_{\text{updaters}} c_{t,i} = \mathcal{X} C_{t-1} + (1-\mathcal{X}) C_t^{\text{updaters}}. \tag{9}$$

$c_{t,i}$ is the consumption of household i at time t, and $1-\mathcal{X}$ is the fraction of the households that update their expectations in the given period and reoptimize their consumption, the "updaters." The remaining households, the "non-updaters," just consume their last period amount of consumption.

Taking first differences of this equation results in

$$\Delta C_t = \mathcal{X} \Delta C_{t-1} + (1-\mathcal{X}) \Delta C_t^{\text{updaters}}. \tag{10}$$

Thus, the change in aggregate consumption is a weighted sum of the changes in total consumption of the "non-updaters" and the "updaters." Carroll and Slacalek (2006) showed that the term related to the "updaters" is approximately mean zero and iid. Therefore, as in the habit-formation framework, we find that the change in consumption follows an AR(1) process.

However, it is important to note that this is the case only when consumption is observed at the same frequency as consumption decisions are made. When consumption is observed at a quarterly frequency but consumption decisions are made on a monthly basis, time-aggregation restrictions change this process so that the log change in aggregated consumption growth approximately follows an ARMA(1,2) process of the form

$$\Delta \log C_t = \mu + \mathcal{X} \Delta \log C_{t-1} + \varepsilon_t + \lambda_1(\mathcal{X})\varepsilon_{t-1} + \lambda_2(\mathcal{X})\varepsilon_{t-2}, \tag{11}$$

where λ_1 and λ_2 are complicated functions of $\mathcal{X}$.[3]

2.2. *Accounting for Measurement Error in Consumption*

As Sommer (2007) and Carroll *et al.* (2011a) noted, the measured consumption C_t^{obs}, as published in the official national accounts, can include three types of noise that are not incorporated in the consumption stickiness theory: sampling measurement errors (small sample problems) u^s, non-sampling measurement errors (imputation of data) u^{ns}, and transitory elements (e.g. weather effects) u^{tr}.

[3]Sommer (2007) showed that the relationship between λ_1, λ_1, and $\mathcal{X}$ is given by

$$\frac{\lambda_1(1+\lambda_2)}{1+\lambda_1^2+\lambda_2^2} = \frac{4+\mathcal{X}^{\frac{1}{3}}(11+\mathcal{X}^{\frac{1}{3}}(20+\mathcal{X}^{\frac{1}{3}}(11+4\mathcal{X}^{\frac{1}{3}})))}{19+\mathcal{X}^{\frac{1}{3}}(32+\mathcal{X}^{\frac{1}{3}}(39+\mathcal{X}^{\frac{1}{3}}(32+19\mathcal{X}^{\frac{1}{3}})))}$$

and

$$\frac{\lambda_2}{1+\lambda_1^2+\lambda_2^2} = \frac{\mathcal{X}^{\frac{2}{3}}}{19+\mathcal{X}^{\frac{1}{3}}(32+\mathcal{X}^{\frac{1}{3}}(39+\mathcal{X}^{\frac{1}{3}}(32+19\mathcal{X}^{\frac{1}{3}})))}.$$

The author points out that the MA parameters take values of $\lambda_1 \approx 0.4$ and $\lambda_2 \approx 0$ for $\mathcal{X} > 0.3$.

Due to this noise, the measured consumption C_t^{obs} does not equal the true (i.e. fundamental) consumption C_t in the short run:

$$\log C_t^{\text{obs}} = \log C_t + \underbrace{u_t^s + u_t^{ns} + u_t^{\text{tr}}}_{\equiv u_t} \Rightarrow \Delta \log C_t = \Delta \log C_t^{\text{obs}} - \Delta u_t. \tag{12}$$

Therefore, written in terms of the measured consumption growth, equation 8 changes to

$$\Delta \log C_t^{\text{obs}} = \mu + \mathcal{X} \Delta \log C_{t-1}^{\text{obs}} + \varepsilon_t + u_t - (1 + \mathcal{X}) u_{t-1} + \mathcal{X} u_{t-2}. \tag{13}$$

2.3. *Wealth Effects Under Sticky Consumption Growth*

As we will observe in this section, the degree of stickiness in consumption, $\mathcal{X}$, determines the extent to which short-run effects of wealth changes on consumption also remain effective in the future and thus become long-lasting. In the presence of sticky expectations or habit formation, changes in household wealth in period t affect the growth of private consumption expenditures not only in the contemporaneous period but also in the upcoming periods. The degree of persistence depends on the amount of stickiness in consumption. We define the immediate—that is, contemporaneous—MPC out of wealth by κ^{im}. The cumulative long-run MPC out of total wealth κ—Carroll *et al.* (2011a) call the latter the "eventual" MPC—is then given by

$$\kappa = \underbrace{\kappa^{\text{im}}}_{t=0} + \underbrace{\mathcal{X}\kappa^{\text{im}}}_{t=1} + \underbrace{\mathcal{X}^2\kappa^{\text{im}}}_{t=2} + \underbrace{\mathcal{X}^3\kappa^{\text{im}}}_{t=3} + \underbrace{\mathcal{X}^4\kappa^{\text{im}}}_{t=4} + \underbrace{\cdots}_{t>4} = \textstyle\sum_{i=0}^{\infty} \mathcal{X}^i \kappa^{\text{im}}. \tag{14}$$

Application of the infinite horizon formula yields

$$\kappa = \frac{\kappa^{\text{im}}}{1 - \mathcal{X}}. \tag{15}$$

Therefore, the stickier the consumption, the larger is the effect of a change in aggregate household wealth on household expenditures in the long run. This is visualized in Figure 1 with two different degrees of stickiness. With a fairly high consumption stickiness of 0.7, the immediate wealth effect $\kappa^{\text{im}} = 0.04$ remains partially effective for a comparatively long period and the long-run MPC out of wealth accumulates to 0.133. In contrast, with a rather low consumption stickiness of 0.3, the immediate wealth effect of 0.04 vanishes fairly quickly, with a long-run wealth effect of only 0.057, less than half that under high consumption stickiness.

Equation 15 suggests that an estimate for the long-run wealth effect κ can be directly obtained from estimates on the consumption stickiness parameter $\mathcal{X}$ and the immediate wealth effect κ^{im}. To estimate the latter, we cannot directly regress the change in consumption in period t on the contemporaneous change in wealth, since wealth is an end-of-period stock measure. However, when consumption is

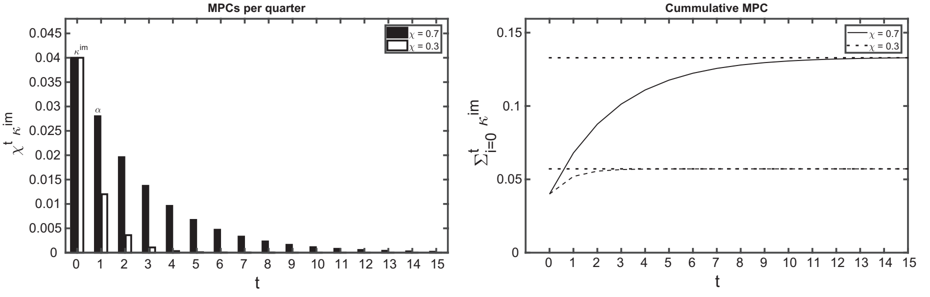

Figure 1. MPCs per Quarter and Cumulative MPC with Different Degrees of Consumption Stickiness

Notes: Given an immediate MPC $\kappa^{\text{im}} = 0.04$, the left-hand panel shows the reactions of consumption growth in period t to a one-unit change in wealth in period 0 with $\mathcal{X} = 0.3$ (white bars) and $\mathcal{X} = 0.7$ (black bars). The right-hand panel shows the corresponding cumulative responses. The dotted horizontal lines represent the long-run wealth effects.

assumed to follow an autoregressive process, the immediate wealth effect can be obtained (see Carroll *et al.* 2011a) by a transformation of the form

$$\kappa^{\text{im}} = \frac{\alpha}{\mathcal{X}}, \tag{16}$$

where $\alpha = \mathcal{X}\kappa^{\text{im}}$ is the one-period wealth effect that represents the effect of a change in wealth in a given period on consumption in the next period. An estimate for α can then be obtained by a regression of the form

$$\Delta \log C_t = \text{const.} + \tilde{\alpha}\Delta \log A_{t-1} + \tilde{v}_t, \tag{17}$$

where A represents asset wealth—that is, financial and housing wealth—and $\tilde{v}$ is an error term. However, since this equation is in terms of log differences, $\tilde{\alpha}$ is an elasticity rather than the MPC out of total wealth, which is usually considered when assessing wealth effects. Carroll *et al.* (2011a) proposed a simple solution to obtain a direct estimate of the MPC by using the ratio of the absolute changes in wealth and consumption relative to an initial level of consumption rather than log changes in wealth and consumption. These new variables are defined as follows: $\partial C_t \equiv (C_t - C_{t-1})/C_{t-2}$ and $\partial A_{t-1} \equiv (A_{t-1} - A_{t-2})/C_{t-2}$. The regression equation then changes to

$$\partial C_t = \text{const.} + \alpha \partial A_{t-1} + v_t, \quad \text{where } v_t \sim N(0,\sigma_v^2). \tag{18}$$

Thus, if wealth increases by one unit in a given period, consumption will increase by α units in the next period.

In Section 3, we will discuss how one possibility in order to account for the measurement error in consumption when estimating this equation is to apply an instrumental variables approach. However, as we will observe in Section 4, where we present the results, the estimated coefficients are somewhat sensitive to the choice of instrument. Therefore, we follow Carroll *et al.* (2011a) and adjust the wealth measure slightly, accounting for the fact that today's consumption can also be influenced by wealth changes in periods before $t-1$:[4]

[4]Because the calculations in this study are based on annual rather than quarterly data, the addition of one further lag should be enough.

(19) $$\Delta C_t^{\text{obs}} \approx \alpha \Delta A_{t-1} + \mathcal{X} \alpha \Delta A_{t-2} + v_t = \kappa^{\text{im}} \mathcal{X} (\Delta A_{t-1} + \mathcal{X} \Delta A_{t-2}) + v_t.$$

On that basis, the regression-relevant transformation for wealth changes to

(20) $$\bar{\partial} A_{t-1} = (\Delta A_{t-1} + \mathcal{X} \Delta A_{t-2}) / C_{t-2}^{\text{obs}}$$

and equation 18, involving the one-period MPC out of total wealth, α, changes to

(21) $$\partial C_t^{\text{obs}} = \text{const.} + \alpha \bar{\partial} A_{t-1} + v_t, \quad \text{where } v_t \sim N(0, \sigma_v^2).$$

Estimating α with this wealth measure should increase precision.

Using the estimate on α, the computation of the long-run wealth effect is then given by replacing the immediate effect by the one-quarter wealth effect in equation 15, so that

(22) $$\kappa = \frac{\kappa^{\text{im}}}{1 - \mathcal{X}} = \frac{\frac{1}{\mathcal{X}} \alpha}{1 - \mathcal{X}} = \frac{\alpha}{\mathcal{X}(1 - \mathcal{X})}.$$

Our focus is not only on the effect of changes in total wealth on consumption, but also on the separate effects of changes in financial and housing wealth. To estimate separate MPCs out of financial and housing wealth, the approach of Carroll *et al.* (2011a) can easily be adapted by adjusting equation 18 to

(23) $$\partial C_t = \text{const.} + \alpha^f \partial A_{t-1}^f + \alpha^h \partial A_{t-1}^h + v_t,$$

where A^f represents financial wealth and A^h (net) housing wealth.

The one-period MPCs out of financial and housing wealth are α^f and α^h, and the long-run MPCs can be calculated as

(24) $$\kappa^f = \frac{\alpha^f}{\mathcal{X}(1 - \mathcal{X})}, \kappa^h = \frac{\alpha^h}{\mathcal{X}(1 - \mathcal{X})}.$$

For a detailed discussion on the potential of housing wealth effects in Switzerland, see Galli (2017).

3. Estimation Strategy and Data

In this section, the consumption stickiness–based approach to estimating wealth effects is applied for the case of Switzerland. In contrast to Carroll *et al.* (2011a) and Slacalek (2009), who solely relied on IV regressions to estimate the stickiness parameter, this study additionally uses a Kalman filter technique as a cross-check in order to avoid overreliance on the choice of instruments.

I also make use of Bayesian inference, which seems attractive in this framework. First, this allows the inclusion of theoretically or empirically motivated beliefs on the degree of consumption stickiness and the magnitude of wealth effects through the choice of priors. For example, one possibly wants to ensure that the estimated autoregressive process for consumption growth is stationary, using a prior on $\mathcal{X}$, which is restricted to lying between zero and one. Another example would be to center the priors on the MPCs around the estimation results from cointegration estimates of other countries. Second, by using Bayesian estimation techniques, we easily obtain distributions for the estimated wealth effects, despite the non-linearity of the corresponding parameters. This permits a more detailed analysis of the degree and symmetry of uncertainty surrounding the estimated MPCs. Third, as highlighted in Kim and Nelson (1999), when estimating state-space models using Bayesian estimation, inferences on the states are not conditional on the estimated values of the hyperparameters but based on the joint distribution of the state variable and the hyperparameters. This will be of interest in Section 3.1.2, where the degree of stickiness in consumption and the path of true consumption over time are estimated using the Kalman filter approach. Furthermore, compared to maximum likelihood, we also avoid potential convergence and starting value issues.

To estimate the parameters of interest—the consumption stickiness parameter $\mathcal{X}$, the short-run wealth effects κ^{im} and α, and eventually the ultimate object of interest, the long-run MPC κ—we make use of the fact that the two parameters α and $\mathcal{X}$, or, in general, the models given in equations 8 and 18, can be estimated independently. This is because, for each equation, the data likelihood is independent when the two error terms, ε and v, as well as the priors are independent.

3.1. *Estimation of the Consumption Stickiness Parameter*

To estimate the consumption stickiness parameter, we can use only data on the observed consumption C_t^{obs}, because the true consumption C_t is unobserved. However, because the observed consumption contains measurement error (as discussed in Section 2), estimation of equation 15 by ordinary least squares would yield an inconsistent estimate of $\mathcal{X}$, since $Cov[\Delta \log C_{t-1}, \varepsilon_t + u_t - (1 + \mathcal{X})u_{t-1} + \mathcal{X}u_{t-2}] \neq 0$; that is, the independent variable is correlated with the error term. Sommer (2007) proposed two ways to tackle this issue: an instrumental variables estimation (IV) or a Kalman filter approach (KF). Both account for measurement error, either by using adequate instruments (IV) or by explicitly modeling the measurement error component (KF).

3.1.1. A Bayesian Instrumental Variables Approach

One solution to overcome the problem of the correlation between the independent variables and the error term is to estimate equation 15 using an instrumental variables approach. This requires finding adequate instruments that are correlated with true consumption but not with the measurement errors. Carroll *et al.* (2011a) proposed lagged wealth, plus possibly the nominal interest rate and consumer expectations on unemployment, as instruments. Other common instruments are disposable income or compensation of employees.

As it turns out, finding good instruments is rather difficult for Swiss private consumption. Possible candidates either show little or no correlation with consumption (e.g. interest rates), or the time series is not long enough (e.g. consumer expectations on unemployment). Apart from lagged wealth, the only remaining straightforward variables are the consumer sentiment index and lagged disposable income.[5]

To estimate by instrumental variables within a Bayesian framework, we follow Kleibergen and Zivot (2003), Rossi *et al.* (2005), and, in particular, Cogley and Startz (2012). Applying their approach to the present framework, the structural equation is given by $\partial C_t = \mathcal{X}\partial C_{t-1} + \varepsilon_t$, or in matrix notation,

$$\partial C^{\text{obs}} = \mathcal{X}\partial C^{\text{obs}}_{-1} + \varepsilon. \tag{25}$$

In a two-stage style using instrument(s) Z, the first-stage equation is given by $\partial C^{\text{obs}}_{t-1} = \gamma Z_{t-2} + v_t$, or in matrix notation,

$$\partial C^{\text{obs}}_{-1} = Z\gamma + v. \tag{26}$$

Substituting the first-stage equation into the structural equation yields the second-stage equation (also known as the restricted reduced form):

$$\partial C^{\text{obs}} = Z\gamma\mathcal{X} + \varepsilon + v\mathcal{X}. \tag{27}$$

Putting the last two equations in a seemingly unrelated regression form, we obtain

$$\begin{bmatrix} \partial C^{\text{obs}} \\ \partial C^{\text{obs}}_{-1} \end{bmatrix} = \begin{bmatrix} Z & 0 \\ 0 & Z \end{bmatrix} \begin{bmatrix} \gamma\mathcal{X} \\ \gamma \end{bmatrix} + \underbrace{\begin{bmatrix} \varepsilon + \mathcal{X}v \\ v \end{bmatrix}}_{\equiv w}, \tag{28}$$

with $w_t \overset{\text{iid}}{\sim} N(0,\Sigma_w)$.

In terms of priors, I use a normal prior for the consumption stickiness parameter $\mathcal{X}$ with mean $\underline{\mathcal{X}} = 0$, variance $\underline{V}_{\mathcal{X}}$, and a truncation on the restricted region (0,1). By doing so, we ensure that the autoregressive process of consumption growth is stationary and the autoregression coefficient is positive. For the instrument coefficient vector, γ, I use a normal prior with mean vector $\underline{\gamma} = 0$ and diagonal covariance matrix $\underline{V}_{\gamma}$. For Σ_w, I use an inverse Wishart prior with scale matrix $\underline{S}$ and degrees of freedom $\underline{DF}$. The particular forms of these priors are chosen so that all conditional posterior distributions of the parameters are of known forms. This allows working with the Gibbs sampler as a sampling technique for approximating the marginal posterior distributions of the parameters. These are obtained by closely following Cogley and Startz (2012). The specific choices of hyperparameters for the priors will be discussed in Section 4. Details of the sampling procedure can be found in the Appendix (in the Online Supporting Information).

3.1.2. A Bayesian Kalman Filter Approach

The difficulty of finding good instruments in our context increases the likelihood of experiencing a weak-instrument problem. Therefore, stickiness parameter $\mathcal{X}$ is alternatively estimated by explicitly modeling the measurement error and setting up a state-space system. The two underlying expressions are

[5]For disposable income, an endogeneity problem can arise since it comes from the same source as the dependent variable (national accounts), so that the measurements can be correlated. Lagging disposable income by one period should help reduce this problem.

equations 8 and 12, or equations 11 and 12 when consumption decisions are made at a lower frequency than consumption is observed.

The state-space form system for the more general case, where consumption decisions are made on a monthly basis and consumption is observed at a quarterly frequency, is represented by the measurement equation

$$\Delta \log C_t^{\text{obs}} = \begin{bmatrix} 1 & 0 & 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} \Delta \log C_t \\ -u_t \\ \Delta u_t \\ \varepsilon_t \\ \varepsilon_{t-1} \end{bmatrix} \tag{29}$$

and the transition equation

$$\underbrace{\begin{bmatrix} \Delta \log C_t \\ -u_t \\ \Delta u_t \\ \varepsilon_t \\ \varepsilon_{t-1} \end{bmatrix}}_{\beta_t} = \begin{bmatrix} \mathcal{X} & 0 & 0 & \lambda_1(\mathcal{X}) & \lambda_2(\mathcal{X}) \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \end{bmatrix} \underbrace{\begin{bmatrix} \Delta \log C_{t-1} \\ -u_{t-1} \\ \Delta u_{t-1} \\ \varepsilon_{t-1} \\ \varepsilon_{t-2} \end{bmatrix}}_{\beta_{t-1}} + \begin{bmatrix} \varepsilon_t \\ -u_t \\ u_t \\ \varepsilon_t \\ 0 \end{bmatrix}, \tag{30}$$

with

$$Q = \begin{bmatrix} \sigma_\varepsilon^2 & 0 & 0 & \sigma_\varepsilon^2 & 0 \\ 0 & \sigma_u^2 & -\sigma_u^2 & 0 & 0 \\ 0 & -\sigma_u^2 & \sigma_u^2 & 0 & 0 \\ \sigma_\varepsilon^2 & 0 & 0 & \sigma_\varepsilon^2 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}. \tag{31}$$

If consumption decisions are made at the same frequency as consumption is observed, the estimation setup still applies after setting $\lambda_1 = \lambda_2 = 0$. For Switzerland, initial maximum likelihood estimates indicate that $\mathcal{X}$ depends only to a negligible extent on the inclusion of lagged terms of ε, which suggests that consumption decisions are made at a lower than monthly frequency. Therefore, to be able to compute κ in a simplified manner, this is assumed in the remainder of this paper.

In terms of priors, I use a normal prior for $\mathcal{X}$, which is given by $\mathcal{X} \sim N[\underline{\mathcal{X}} = 0, V_{\mathcal{X}}]$, again truncated on the restricted region (0,1). The prior for σ_ε^2 is given by $\sigma_\varepsilon^2 | \mathcal{X} \sim IG[\frac{d_1}{2}, \frac{d_2}{2}]$.[6] The prior for σ_u^2 is given by $\sigma_u^2 \sim IG[\frac{d_3}{2}, \frac{d_4}{2}]$. As before, the particular forms of these priors are chosen so that all conditional posterior distributions of the parameters are of known forms. This allows working with the Gibbs sampler as a sampling technique for approximating the marginal posterior distributions of the parameters. For the state-space setup, these are obtained following Kim and Nelson (1999). The specific choices of hyperparameters for the priors will be discussed in Section 4. Details of the sampling procedure can be found in the Appendix.

[6]One could also rewrite the prior and posterior as an inverse Wishart distribution so that $\sigma_\varepsilon^2 | \mathcal{X} \sim IW[d_2, d_1]$ and $\sigma_\varepsilon^2 | \mathcal{X}, \Delta C_t \sim IW\left[d_2 + (\xi - \xi_{-1}\mathcal{X})'(\xi - \xi_{-1}\mathcal{X}), d_1 + T\right]$.

3.2. *Estimation of the Short- and Long-Run Wealth Effects on Consumption*

The marginal posterior distribution of the one-period MPC out of total wealth α is obtained by estimating equation 20 using the observed consumption C_t^{obs}, adding an additional step to the Gibbs sampling procedure from Section 3.1.1 or 3.1.2, respectively. I use a normal prior for α with mean $\underline{\alpha} = 0$ and variance $\underline{V}_\alpha$ and an inverse gamma prior for σ_v^2 with scale parameter $\underline{\theta}$ and degrees of freedom $\underline{T}$. The specific choices of hyperparameters for the priors will be discussed in Section 4.

Following Koop (2003) or Lancaster (2004), to sample from $p(\sigma_v^2|\alpha)$, we make use of the fact that when α is assumed to be known, the conditional distribution of σ_v^2 is inverse gamma and is given by

$$\sigma_v^2|\alpha \sim IG\left(\overline{T} = \underline{T} + T, \overline{\theta} = \underline{\theta} + (C - \partial A_{-1}\alpha)'(C - \partial A_{-1}\alpha)\right). \tag{32}$$

To sample from $p(\alpha|\sigma^2)$, we make use of the fact that when σ_v^2 is known, the conditional distribution of α is normal and given by

$$\alpha|\sigma_v^2 \sim N\left(\overline{\alpha} = \overline{V}_\alpha(\underline{V}_\alpha^{-1}\underline{\alpha} + \frac{1}{\sigma_v^2}\partial A'_{-1}\partial C_t), \overline{V}_\alpha = (\underline{V}_\alpha^{-1} + \frac{1}{\sigma_v^2}\partial A'_{-1}\partial A_{-1})^{-1}\right).$$

By replacing $\partial A'_{-1}\partial C_t$ with $\partial A'_{-1}\partial A_{-1}\alpha^{\text{ols}}$, we see that the conditional posterior mean of α is a weighted average of the prior mean $\underline{\alpha}$ and the OLS estimate α^{ols}. To obtain approximate marginal distributions of the one-period MPC of wealth, α and σ_v^2, we add the draws from the corresponding conditional posteriors to the Gibbs sampling procedure.

Next, the contemporaneous MPC out of total wealth, κ^{im}, is calculated according to equation 18. Since we assume $\mathcal{X}$ and α to be independent of each other, the posterior distribution of the contemporaneous wealth effect, $p(\kappa^{\text{im}}|\mathcal{X},\alpha)$, is obtained by calculating $\kappa^{\text{im}} = \frac{\alpha}{\mathcal{X}}$ for each draw of $(\mathcal{X},\alpha)$ from the Gibbs sampling procedure. The prior for κ^{im} is implicitly given by the priors on $\mathcal{X}$ and α.

Finally, the marginal posterior distribution of the eventual wealth effect of consumption, $p(\kappa|\mathcal{X},\alpha)$, follows directly from equation 24 and is obtained similarly to the posterior for the contemporaneous wealth effect, calculating $\kappa = \frac{\alpha}{\mathcal{X}(1-\mathcal{X})}$ for each draw of $(\mathcal{X},\alpha)$. The prior for κ is implicitly given by the priors on $\mathcal{X}$ and α.

3.3. *Data*

The Swiss dataset is the same as that in Galli (2017) and covers the period from 1981 to 2012.[7] Both consumption and wealth are used in real per capita terms. Data on all measures of consumption (total, non-durable, and non-housing) and on the consumption deflator are obtained from the official national accounts for Switzerland, published by the Swiss Federal Statistical Office (annual figures) and the Swiss State Secretariat of Economic Affairs (quarterly, calendar, and seasonally adjusted figures).

Regarding financial wealth, the asset side consists of money and deposit holdings, debt securities, shares, units in collective investment schemes, structured

[7]Disposable income is published with a lag of two years in Switzerland was not available yet for the year 2013 when this paper was written.

products, and claims against pension funds and insurances. On the liability side, financial wealth consists of loans (mortgages, consumer loans, and other loans) and other accounts payable. Annual figures from 1999 onwards come from the official Swiss financial accounts. For 1980–98, the annual figures reflect SNB internal retropolations, which are based on the statistic on bank balance sheets, the securities deposits statistic, banknote circulation data, postal account data, and insurance statistics. Quarterly financial wealth figures are mostly based on bank statistics if available. For components where quarterly observations are missing, dynamics are approximated by relevant indicators such as the money stock, bond indices, and stock market indices.

Housing wealth consists of houses, condominiums, and rental apartments valued at market prices and owned by private households. Annual figures are based on internal estimates using data on dwellings from the Federal Register of Buildings and Dwellings (RBD), published by the Swiss Federal Statistical Office, and data on hedonic price indices (transaction prices) as follows. For each village in Switzerland, one representative standard property for each of the three property types (single-family homes, condominiums, and apartment buildings with rental apartments) is valued by real estate consultancies using hedonic pricing models. These valued standard properties are then multiplied by the number of properties per municipality. For the aggregated property stock over all municipalities, the share of the household sector is taken using a reference value from the Swiss Housing Census of 2000 (the RBD does not include this information). Before 2000, the RBD data are available only at a ten-year frequency (1980 and 1990). Thus, annual figures on the real estate stock for the 1980–99 period are obtained by applying the same method as in Schmid (2013), assuming that the change in the annual real estate stock is proportional to data on newly built housing units. Quarterly figures on housing wealth are obtained by interpolation, using quarterly developments of the relevant hedonic price indices. More details on the calculation of financial and housing wealth can be found in Swiss National Bank (2012).

4. Empirical Results

Most of the results will be based on annual instead of quarterly figures. The reason for this is that quarterly measures of both Swiss private consumption and household wealth reflect only interpolated annual figures and thus have limited additional information content. Instead, the use of interpolated data could lead to erroneous conclusions about the true fundamental dynamics, especially where consumption stickiness is concerned. The use of annual figures also has the advantage that quarterly fluctuations in wealth that are only temporary vanish. The only exception to this strategy of using annual data is the KF approach, where the process for true consumption is set up in quarterly terms. Given the quarterly stickiness parameter $\mathcal{X}_Q$, the annual stickiness is then simply given by $\mathcal{X} = \mathcal{X}_Q^4$.

In what follows, total wealth is defined in net terms; that is, gross financial wealth plus gross housing wealth minus gross liabilities. When working with separate wealth components (financial wealth and housing wealth), the entire netting is performed on the housing wealth side, because 94 percent of Swiss household liabilities consist of mortgage loans and are thus directly linked to housing wealth.[8]

In terms of normal priors for the location parameters, I use variances that are large enough so that the priors become loose. For all inverse Wishart and inverse gamma priors, following Bauwens *et al*. (2003), we set the scale parameters and degrees of freedom toward zero so that the priors become non-informative.

To eliminate constants that are of no interest for the analysis, demeaned data are used for all calculations. I use $D = 30{,}000$ draws with 3,000 burn-in draws.

4.1. *The Consumption Stickiness Parameter*

The estimated marginal posterior distribution for consumption stickiness parameter $\mathcal{X}$ is shown in Figure 2. Depending on the choice of instrument, the posterior median resulting from the IV approach is either 0.41 (with instruments wealth and disposable income) or 0.60 (with instruments wealth and consumer sentiment). The posterior median resulting from the Kalman filter is 0.40.

Being based on annual data, these values are remarkably high and signal the presence of rather large stickiness in Swiss private consumption expenditures. Viewed in a sticky expectation context, this would mean that only approximately half of the households update their expectations in a given year. In terms of habit formation, this result suggests that a positive change in consumption generates roughly as much utility as the actual level of consumption. In other words, habits are quite important.

Comparing the distributions, it must be noted that the variance of the posterior distribution of the consumption stickiness parameter is rather large in the IV case, compared to the one from the KF approach. This may indicate a weak instrument problem.

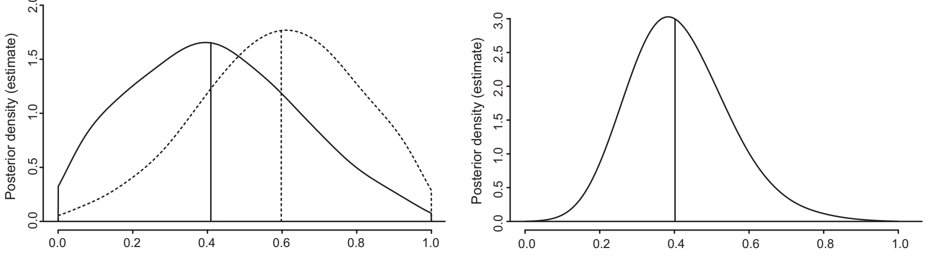

Figure 2. The Posterior Distribution of the Consumption Stickiness Parameter

Notes: The estimated posterior density for stickiness parameter $\mathcal{X}$ is shown. The left-hand panel shows the posterior obtained from the instrumental variable estimation approach with instruments wealth and disposable income (solid line, median: 0.41) and wealth and consumer sentiment (dashed line, median: 0.60). The right-hand panel shows the posterior obtained from the Kalman filter approach (median: 0.40). Median values are denoted by the vertical lines.

[8]As argued in several studies, the use of more disaggregate wealth measures (e.g. deposits, stock market assets, pension wealth, housing wealth, and debt) could potentially be more appropriate because the MPCs of these measures may differ. However, given the limited number of observations, this is difficult to implement in our case.

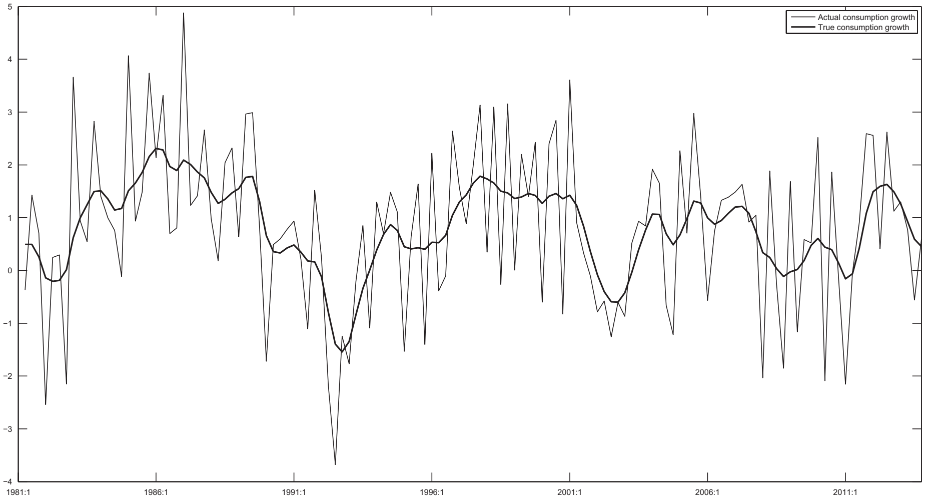

Figure 3. The Actual Consumption Growth Compared to the Estimated Path of the True Consumption Growth

Notes: The Kalman filter estimates for true consumption growth (median values, bold line) are shown, compared to actual quarterly consumption growth in real per capita terms (solid line) for Switzerland.

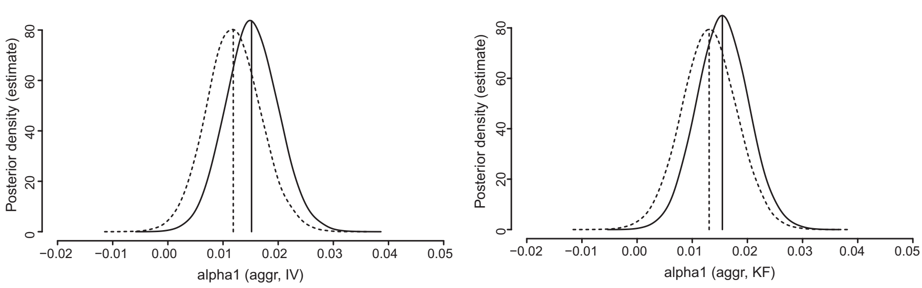

Figure 4. The Posterior Distribution of the One-Period Wealth Effect

Notes: The estimated posterior distribution of the one-period MPC out of total wealth (α) is shown. Left-hand panel: estimates based on $\mathcal{X}_{\mathbf{IV}}$, with control disposable income (solid line, median: 0.015) and with control consumer sentiment (dashed line, median: 0.012). Right-hand panel: estimates based on $\mathcal{X}_{\mathbf{KF}}$ with control disposable income (solid line, median: 0.015) and with control consumer sentiment (dashed line, median: 0.013). Median values are denoted by the vertical lines.

From the Kalman filter, we also obtain smoothed estimated states of true consumption growth. As Figure 3 shows, a substantial fraction of the volatility in quarterly consumption growth is due to measurement error and transitory elements, such as weather effects.

4.2. *The Short- and Long-Run Wealth Effects on Consumption*

The marginal posterior distribution for the one-period wealth effect α is shown in Figure 4. Depending on the approach (IV or KF) and the choice of control variable (disposable income or consumer sentiment), the median one-period MPC out of total wealth is between 0.012 and 0.015. Thus, if total wealth increases by 1 Swiss franc in a given year, consumption rises by 1.2–1.5 Swiss centime at the median the following year. At the 2012 annual levels of consumption (339 billion CHF) and total net wealth (3029 billion CHF), this means that a 1 percent increase in total net wealth yields a 0.11–0.13 percent increase in consumption the following year.

From the distributions of the one-period wealth effect, we can also calculate the probabilities for the one-period wealth effect to lie above a certain value: 99.3 percent $< p(\alpha > 0|y) <$ 99.9 percent, 65 percent $< p(\alpha > 0.01|y) <$ 88 percent, 26 percent $< p(\alpha > 0.015|y) <$ 51 percent, and 5 percent $< p(\alpha > 0.02|y)$ $<$ 17 percent.

The results for the marginal posterior distribution of the long-run wealth effect $\mathcal{X}$ are shown in Figure 5. The median long-run MPC out of total wealth based on the stickiness parameter from the IV approach is somewhat higher (0.074/0.059, depending on the choice of control) than the MPC based on the KF approach (0.068/0.057, depending on the choice of control). Given these MPC estimates, an increase in total net wealth of one Swiss franc in a given year accumulates—through consumption stickiness—into a long-run consumption increase of 7.4/5.9 centime (IV approach) or 6.8/7.2 centime (KF approach) at the median. At the 2012 annual levels, this means that the infinite horizon effect of a 1 percent increase in total net wealth on consumption lies between 0.5 percent and 0.66 percent.

Compared to the posterior from the KF approach, the one from the IV approach is much more right-tailed. This is due to the higher variance of $\mathcal{X}_{IV}$, which results in more draws near the extreme values of zero and one, so the multiplier $\frac{1}{\mathcal{X}(1-\mathcal{X})}$ in equation 24 becomes larger.

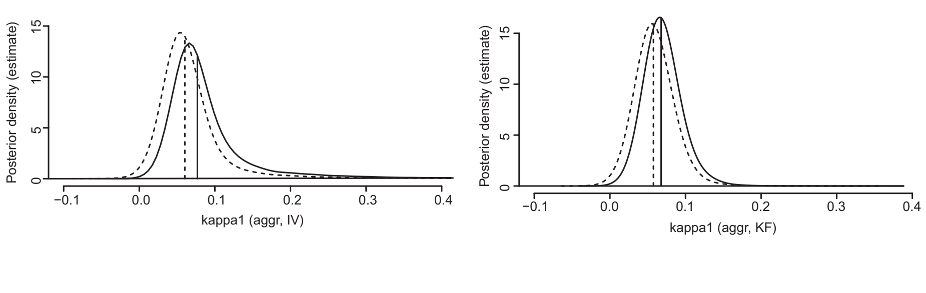

Figure 5. The Posterior Distribution of the Long-Run Wealth Effect

Notes: The estimated posterior distribution of the long-run MPC out of total wealth (κ) is shown. Left-hand panel: estimates based on $\mathcal{X}_{IV}$ and α_{IV} with control disposable income (solid line, median: 0.074) and with control consumer sentiment (dashed line, median: 0.059). Right-hand panel: estimates based on $\mathcal{X}_{KF}$ and α_{KF} with control disposable income (solid line, median: 0.068) and with control consumer sentiment (dashed line, median: 0.057). Median values are denoted by the vertical lines.

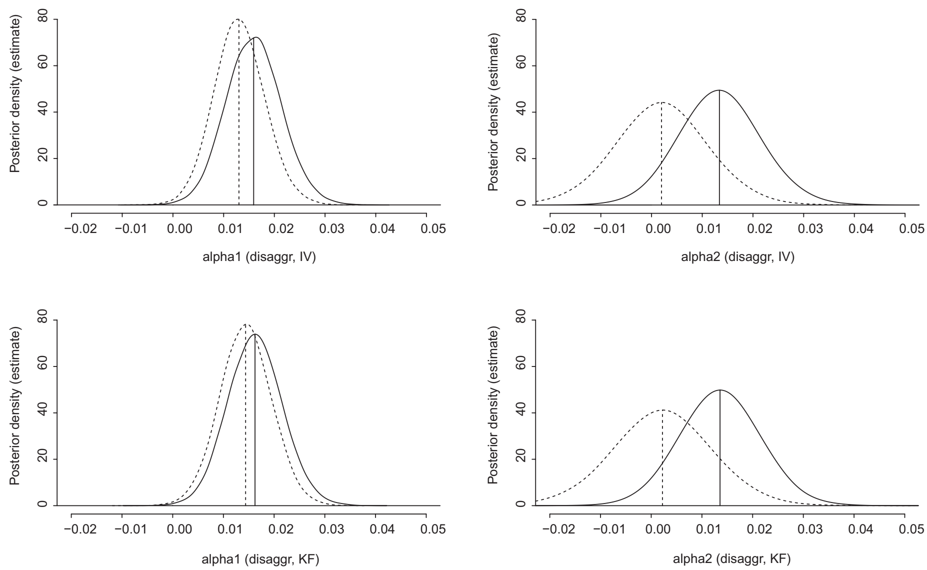

Figure 6. The Posterior Distribution of the Separate One-Period Wealth Effects

Notes: The estimated posterior distributions of the separate one-period MPC out of financial wealth (α^f, left-hand panel) and housing wealth (α^h, right-hand panels) are shown, based on $\mathcal{X}_{\mathbf{IV}}$ (top panels) and $\mathcal{X}_{\mathbf{KF}}$ (bottom panels). Control variables: disposable income (solid line) and consumer sentiment (dashed line). Median values are denoted by the vertical lines.

In terms of probabilities, we obtain 99.3 percent $< p(\kappa > 0|y) <$ 99.9 percent, 63 percent $< p(\kappa > 0.05|y) <$ 84 percent, and 5 percent $< p(\kappa > 0.1|y) <$ 26 percent, depending on the approach and the choice of control variable.

4.3. *Separating Wealth Effects*

The results for the short-run separate wealth effects are shown in Figure 6. Depending on the choice of approach and control variable, the median one-period MPC out of financial wealth, α^f, is estimated to lie between 0.013 and 0.016.

For the median one-period MPC out of housing wealth, α^h, the results are less clear. Whereas the use of the control variable disposable income suggests an MPC of 0.013/0.014 (depending on the approach), the use of the control variable consumer sentiment suggests a median estimate of 0.002, which is very close to zero. Furthermore, the distribution of the housing wealth effect is much less narrow than for financial wealth. Thus, there is much more uncertainty surrounding the housing wealth effect.

Overall, the results suggest that if financial wealth increases by 1 Swiss franc in a given year, consumption rises by 1.3–1.6 Swiss centime at the median in the following year. For housing wealth, it is 0.2–1.4 Swiss centime at the median. At the 2012 annual levels of consumption, financial wealth (2108 billion CHF), and net housing wealth (921 billion CHF), this means that consumption will increase

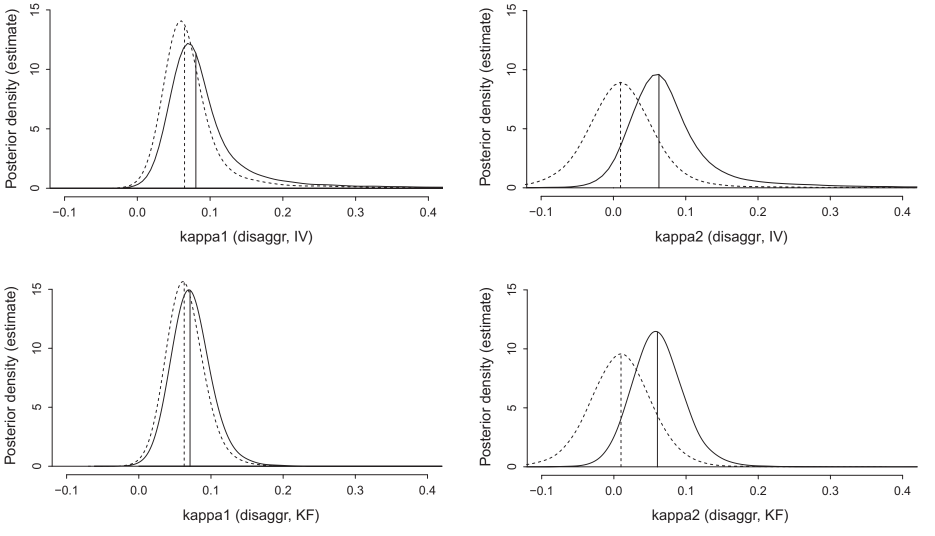

Figure 7. The Posterior Distribution of the Separate Long-Run Wealth Effects

Notes: The estimated posterior distributions of the separate long-run MPC out of financial wealth (κ^f, left-hand panel) and housing wealth (κ^h, right-hand panels) are shown, based on $\mathcal{X}_{\mathrm{IV}}$ (top panels) and $\mathcal{X}_{\mathrm{KF}}$ (bottom panels). Control variables: disposable income (solid line) and consumer sentiment (dashed line). Median values are denoted by the vertical lines.

by 0.08–0.1 percent when financial wealth increases by 1 percent and by 0.01–0.04 percent when net housing wealth increases by 1 percent.

In terms of probabilities, the results are 99.7 percent < $p(\alpha^f > 0|y)$ < 99.9 percent, 73 percent < $p(\alpha^f > 0.01|y)$ < 86 percent, 26 percent < $p(\alpha^f > 0.015|y)$ < 54 percent, and 4 percent < $p(\alpha^f > 0.02|y)$ < 17 percent, while 59 percent < $p(\alpha^h > 0|y)$ < 95 percent, 18 percent < $p(\alpha^h > 0.01|y)$ < 69 percent, 7 percent < $p(\alpha^h > 0.015|y)$ < 43 percent, and 2 percent < $p(\alpha^h > 0.02|y)$ < 20 percent.

For the separate long-run wealth effects, $\mathcal{X}^f$ and $\mathcal{X}^h$, the marginal posteriors are shown in Figure 7. The median long-run MPC out of financial wealth is between 6.3 and 7.8 Swiss centime. The one out of housing wealth is either 6.0/6.7 centime (control variable disposable income) or 1.0 centime (control variable consumer sentiment). Given these MPC estimates, a 1 percent increase in financial wealth accumulates—through consumption stickiness—into a long-run effect on consumption of 0.39–0.48 percent, respectively. A 1 percent increase in housing wealth yields an increase in consumption of 0.03–0.18 percent in the long run.

The probability of changes in financial wealth having a positive long-run effect on consumption is between 99.96 percent and 99.9 percent; for housing wealth, it is only between 59 percent and 96 percent. The other probabilities are 72 percent < $p(\kappa^f > 0.05|y)$ < 85 percent and 8.4 percent < $p(\kappa^f > 0.1|y)$ < 29 percent, while 16.6 percent < $p(\kappa^h > 0.05|y)$ < 67 percent and 2 percent < $p(\kappa^h > 0.1|y)$ < 25 percent.

TABLE 1
A Summary of the Results for Switzerland

		Aggregate Wealth			Separate Wealth	
	Time Range	$\mathcal{X}$	MPC_w^{im}	MPC_w^{ev}	Financial MPC_w^{ev}	Housing MPC_w^{ev}
Switzerland (IV)	1980–2012	0.80/0.88	1.3/0.6	7.4/5.9	7.8/6.5	6.7/1.0
Switzerland (KF)	1980–2012	0.80	1.3/1.1	6.8/5.7	7.1/6.3	6.0/1.0

Controls: disposable income/consumer sentiment.
Note: The estimates for $\mathcal{X}$ and κ^{im} are transformed to quarterly frequency.

4.4. *Comparison with Results from Other Countries and Cointegration-Based Studies*

Carroll *et al*. (2011a) applied the sticky consumption approach to U.S. data. Their results suggested that the stickiness in *quarterly* U.S. consumption growth was approximately 0.6–0.7. The immediate wealth effect in the United States was estimated to be approximately 2 cents for a one-dollar increase in wealth, while the long-run total wealth effect accumulated to 5–7 cents. For separate wealth components, the long-run financial wealth effect was found to be approximately 4–6 cents, and the long-run housing wealth effect approximately 9–16 cents.

Slacalek (2009) extended the application of the new approach to a broad set of 16 countries. The consumption stickiness coefficient $\mathcal{X}$ varied across countries from 0.14 (Germany) to 0.92 (Finland). Large variations were also present in the immediate and long-run MPCs. The largest wealth effects were found in Australia, Japan, Denmark, Finland, and Spain. In France, Germany, Italy, Austria, and Belgium, no wealth effects seemed to be present. The largest financial wealth effects were found for Australia, Canada, and Japan. The estimates for Germany and Italy were also quite high, but hardly statistically significant. In terms of housing wealth effects, the largest MPC estimates were found for Australia, Japan, the United Kingdom (U.K.), and especially Denmark and Finland.

Slacalek (2009) also performed a comparison across country groups. He concluded that total wealth effects seem to be larger in countries with "complete" mortgage markets, in market-based economies, in the U.K., the U.S., and in non-euro-area countries.[9] The same ranking was found for housing wealth effects.

Table 1 summarizes this study's results for Switzerland, transformed to quarterly frequency. Consumption stickiness in Switzerland is among the highest estimates in a comparison with the international results from Slacalek (2009), similar to the degree of stickiness found for Australia, Finland, Ireland, Spain, and Sweden. The one-period wealth effect, in contrast, is rather small compared to other countries. However, given the high degree of stickiness of Swiss private consumption, the wealth effect accumulates to a larger extent over time, so that the long-run effect eventually lies somewhere in the middle of the international results. The same applies to the separate financial and housing wealth effects.

[9]He distinguished between "complete" and "incomplete" mortgage markets using the new mortgage market index of Cardarelli *et al*. (2008). Market-based countries are countries where the stock market plays a more important role than banks in financial transmission.

When comparing the results to those obtained in the cointegration-based study for Switzerland of Galli (2017), wealth effects are found to be substantially higher than indicated by the cointegration-based results, which suggests—driven by the sample since 2001—that wealth effects are hardly present. Thus, changes in wealth do have a long-run effect on consumption in Switzerland, but a stable level relationship between consumption and wealth no longer seems to exist. This also implies the absence of error-correction mechanisms.

5. Conclusions

For Switzerland, the question of how changes in wealth affect household expenditures is particularly interesting today. Large increases in stock prices and real estate prices have led to a strong increase in Swiss household wealth over the past few years. From 2004 to 2014, per capita wealth rose by almost 40 percent. To assess the extent to which such increases in household wealth affect household expenditures, most empirical studies have used cointegration-based approaches. These approaches rely on the existence of a stable long-run relationship among consumption, wealth, and income. However, as documented in Galli (2017), no such stable relationship among consumption, wealth, and income has seemed to exist in Switzerland since 2001. This makes cointegration-based results for wealth effects—which suggest that no wealth effects are present in Switzerland—much less reliable.

Motivated by this issue, this study has applied the relatively new approach of Carroll *et al.* (2011a) to estimate long-run wealth effects in Switzerland. The approach relies not on cointegration but, rather, on sticky consumption growth, motivated by consumption habits or sticky expectations. In both cases, long-run wealth effects are then the result of short-run reactions of households to changes in wealth that become long-lasting.

This paper contains four main results. First, there seems to be a remarkably high degree of consumption stickiness in Switzerland. Viewed in a sticky expectation context, only approximately half of households update their expectations and optimize their consumption behavior in a given year. Therefore, consumption growth is quite persistent even on an annual basis. In terms of habit formation, the results suggest that a positive change in consumption generates roughly as much utility as the actual level of consumption. In other words, habits are quite important.

Second, wealth effects in Switzerland are substantially larger (between 5.7 and 7.4 Swiss centime at the median) than indicated by the cointegration-based results from Galli (2017), which suggests—driven by the sample since 2001—that wealth effects are hardly present in Switzerland. Thus, changes in wealth do have a long-run effect on consumption, but a stable level relationship between consumption and wealth no longer seems to exist. This also implies the absence of error-correction mechanisms.

Third, the results for separate financial and housing wealth effects suggest that the median one-period MPC is somewhat higher out of financial wealth than out of total wealth, and the one out of housing wealth is somewhat smaller. In addition, there is a much higher degree of uncertainty surrounding the latter. This supports the point mentioned by Galli (2017), that changes in housing wealth do not necessarily need to create aggregate gains and thus affect aggregate consumption.

Fourth, a comparison with estimates for other countries reveals that the degree of stickiness in Swiss private consumption is among the highest. Furthermore, in terms of wealth effects, the short-run wealth effect is rather small compared to other countries. However, given the high degree of stickiness of Swiss private consumption, changes in wealth in a given period have an effect on consumption not only in the next period but also, to a large extent, in upcoming periods. Thus, the accumulated long-run effect lies somewhere in the middle of the international results. The same applies to the separate financial and housing wealth effects.

In this paper, the Kalman filter approach and the IV approach were used separately to obtain two alternative estimates of the stickiness parameter. In further research, these two approaches could be combined in a model similar to the one in Jin and Jorgenson (2010). This would have the advantage that the stickiness parameters would be based on information of both past consumption and wealth, while at the same time having measurement errors explicitly modeled.

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Supporting Information

Additional supporting information may be found in the online version of this article at the publisher's web site:

Appendix: Sampling Techniques

A.1. Consumption Stickiness Parameter

A.1.1. Instrumental Variables Approach

A.1.2. Kalman Filter Approach

A.2. Short-Run and Long-Run Wealth Eects on Consumption