

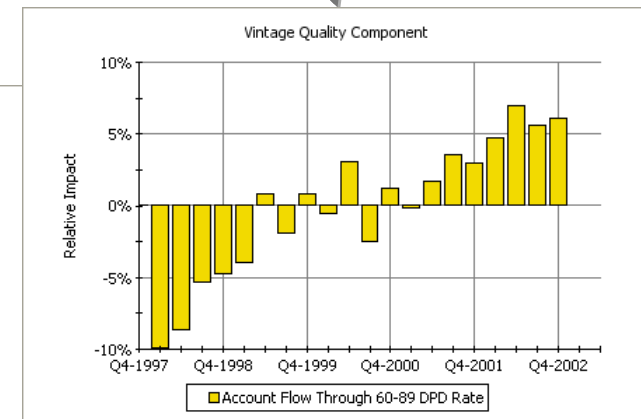
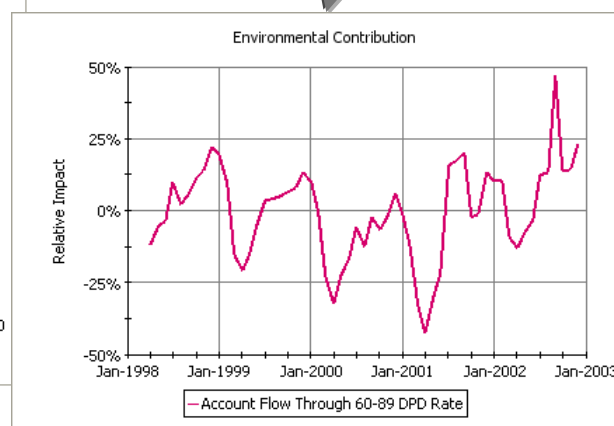
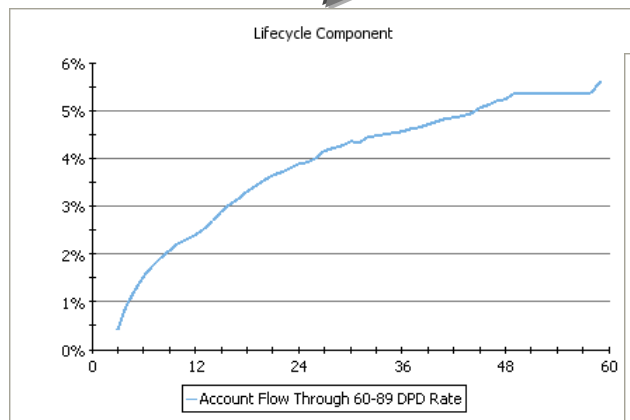
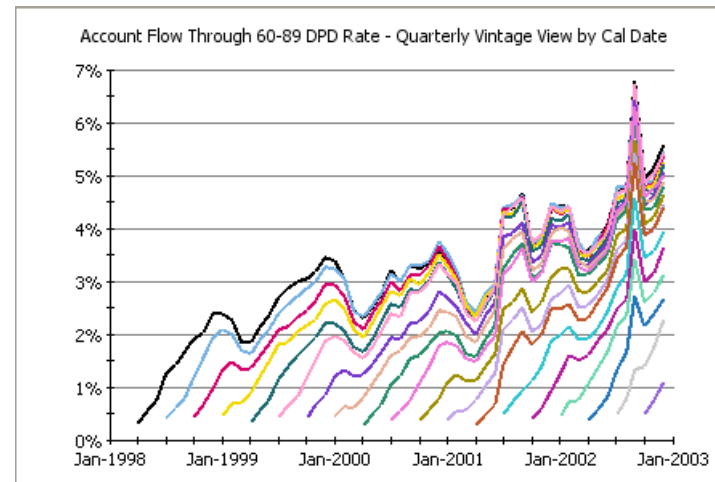
# Estimating Effects of Adjustable Mortgage Rate Resets

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# Dual-time Dynamics (DtD)

- Vintage-level data then is decomposed into functions of months-on-books (maturation), calendar date (environment or exogenous), and vintage (quality).



# Nonlinear Decomposition: Mortgage Rate Resets

For a given performance rate,  $r(v, a, t)$ , one could construct a nonlinear model with dependence

upon vintage, months-on-books (vintage age), and a calendar date:

$$r(v, a, t) = e^{f_m(a)} \cdot e^{f_g(t)} \cdot e^{f_Q(v)} \cdot \mathcal{E}_{v,a,t}, \text{ where}$$

$e^{f_m(a)}$  - maturation function, capturing product lifecycle effects,

$e^{f_Q(v)}$  - vintage quality, measuring credit quality issues due to changes in underwriting,

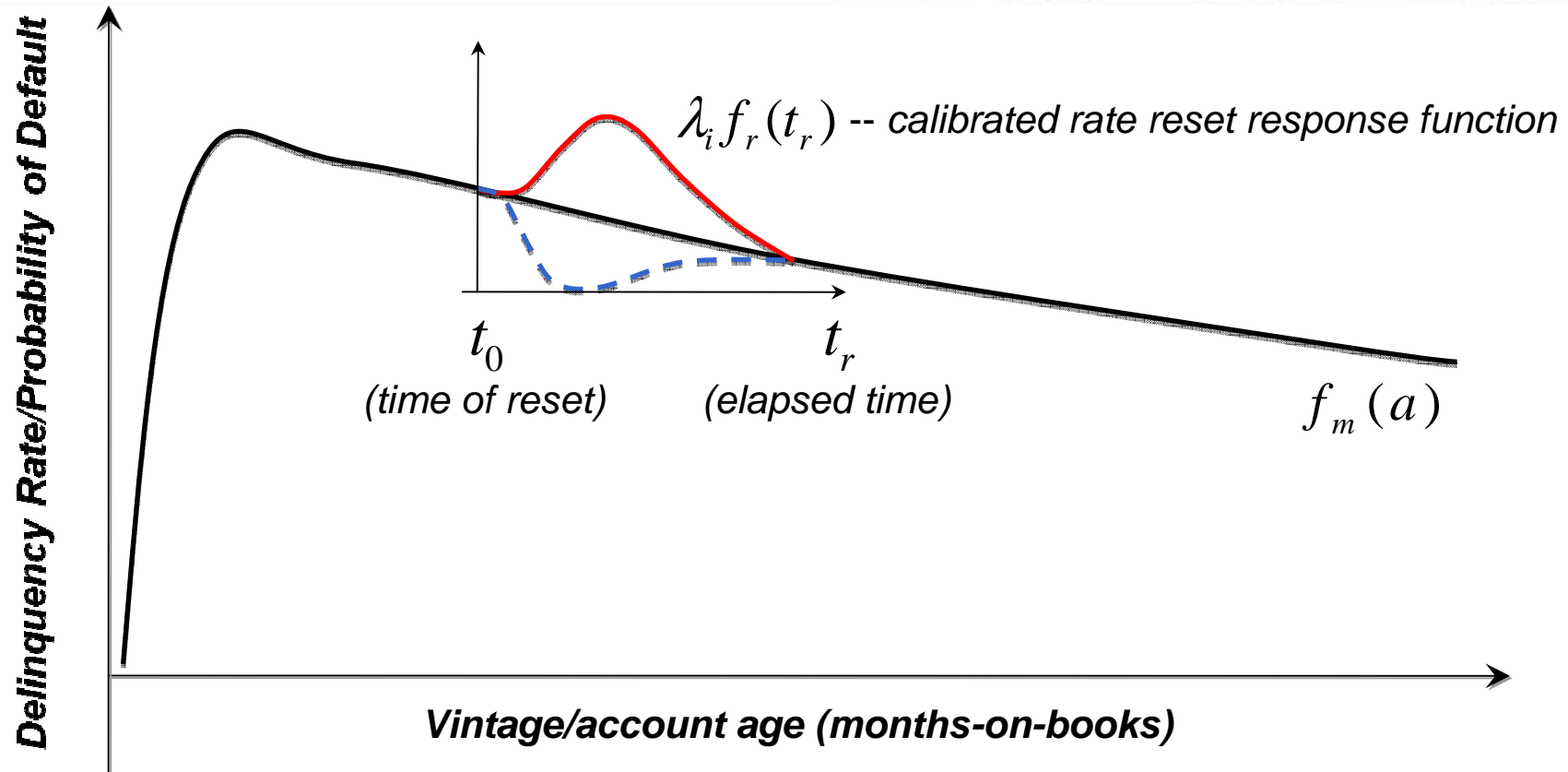
$e^{f_g(t)}$  - exogenous curve, capturing calendar time shocks to the vintages,

$\mathcal{E}_{v,a,t}$  - residual error from modeling.

For products that are not actively managed (fixed-rate mortgages, auto loans), the maturation function is essentially one-dimensional. For adjustable mortgages, the response of the consumer to the change in the interest rate should be taken into account. The maturation function can now be viewed as a function of both account age and the elapsed time since the rate reset,  $e^{f_m(a,t_r)}$  :

$$r(v, a, t) = e^{f_m(a,t_r)} \cdot e^{f_g(t)} \cdot e^{f_Q(v)} \cdot \mathcal{E}_{v,a,t}$$

# Two-dimensional Maturation

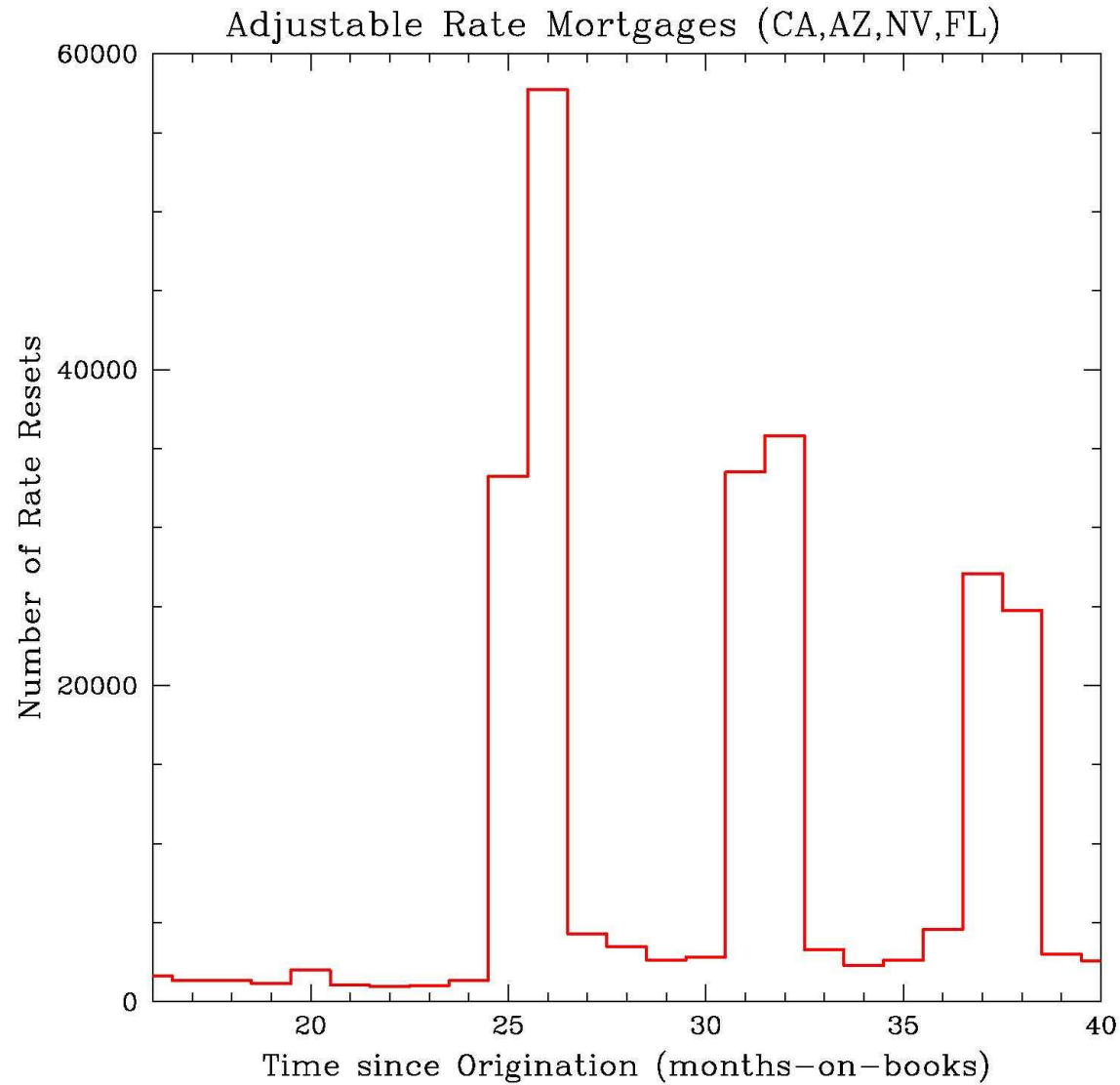


To simplify the problem, we can present the maturation function as the combination of two separate functions of account age and time since the mortgage rate reset:

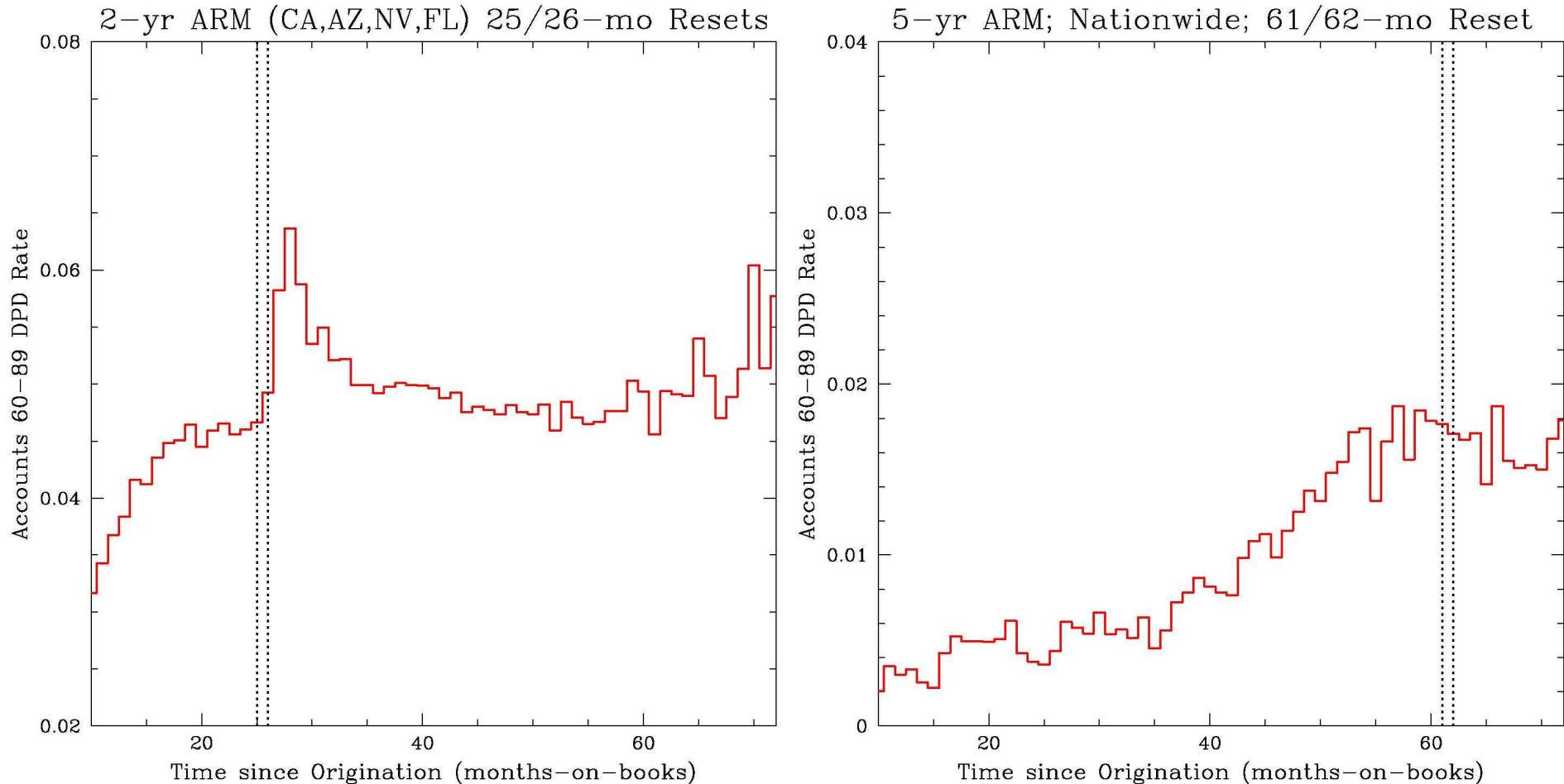
$$e^{f_m(a, t_r)} = e^{f_m(a)} \cdot e^{\lambda_i f_r(t_r)}$$

$f_m(a)$  is one-dimensional maturation function that can be estimated using the standard nonlinear decomposition procedure and treated as a fixed input.  $\lambda_i f_r(t_r)$  is the calibrated Reset Response function .

# Mortgage Rate Resets Age-Number Distribution: 2-yr ARM Example

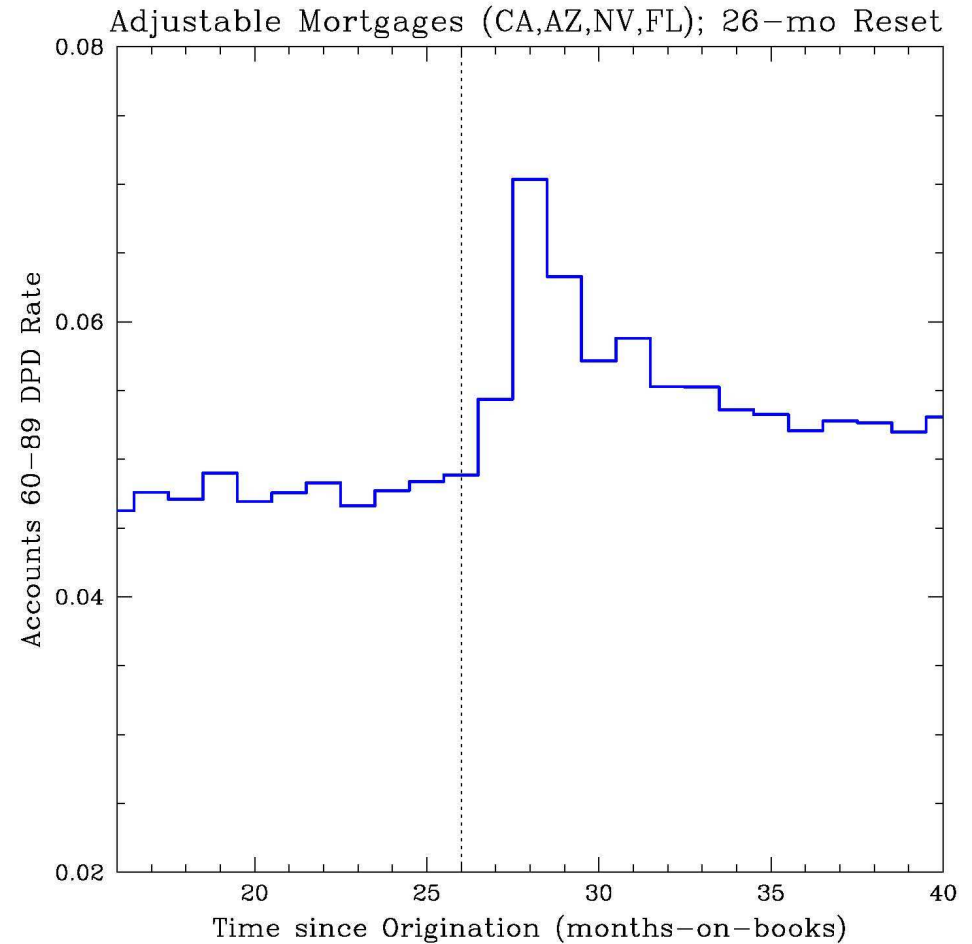
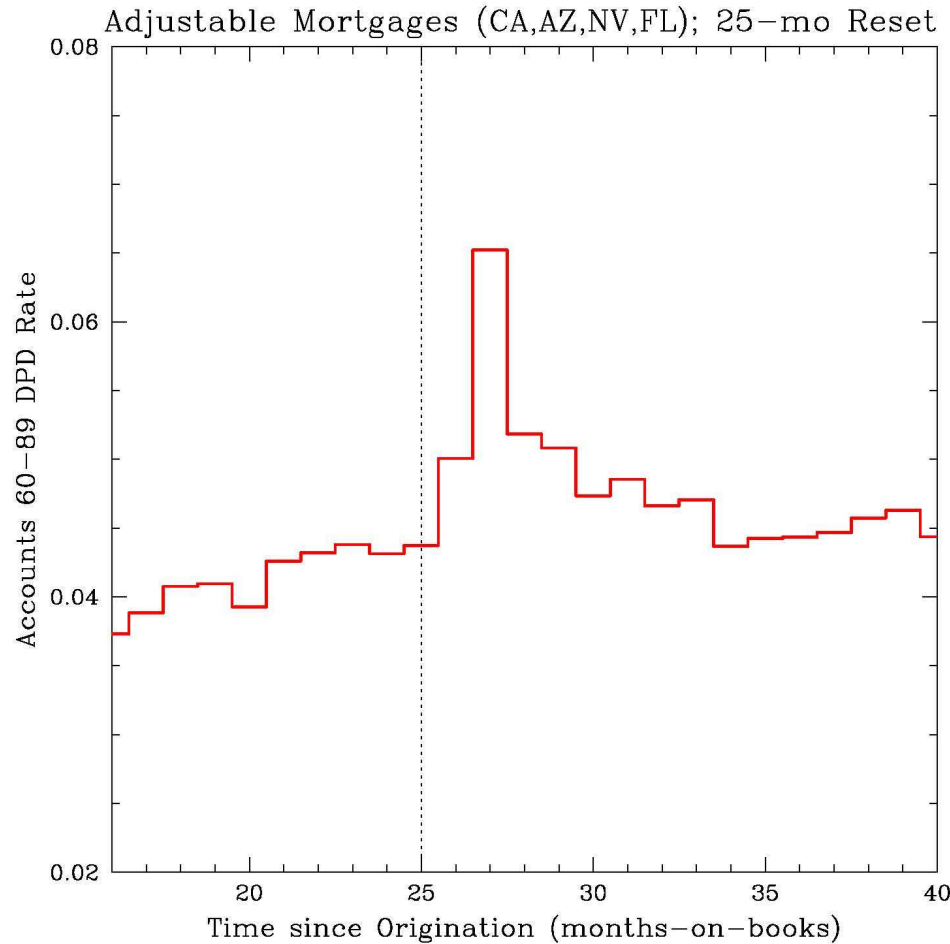


# Two-dimensional Maturation: 2-yr ARM vs. 5-yr ARM



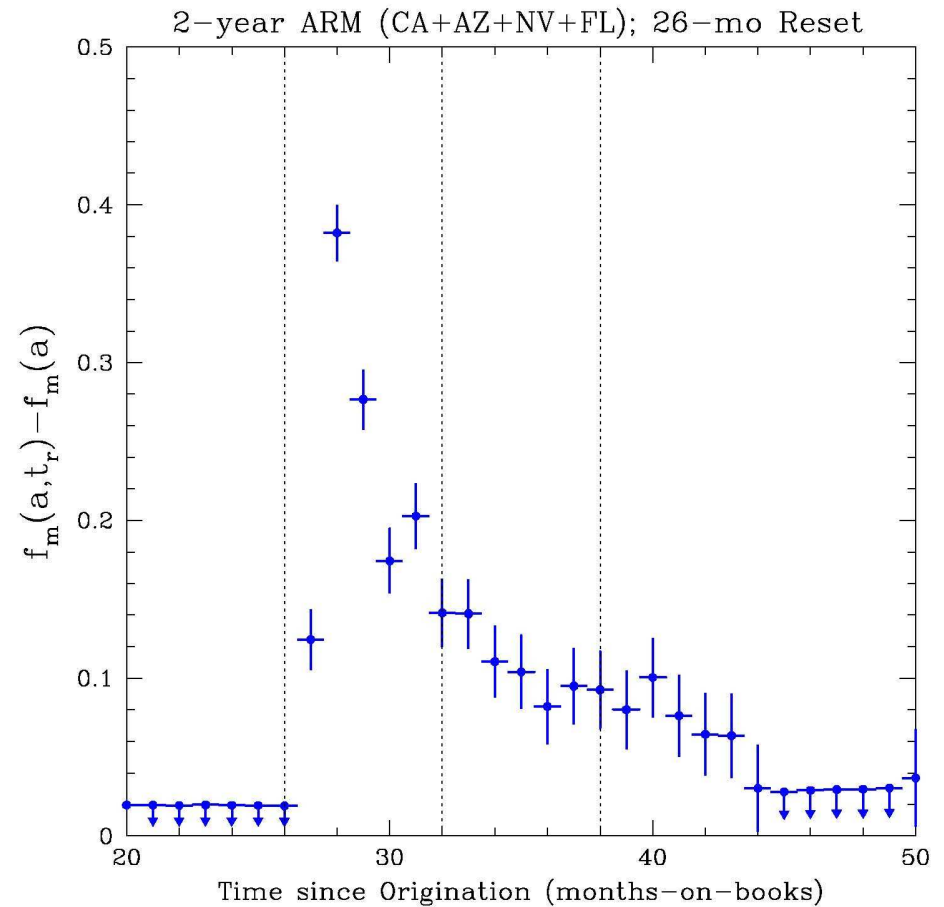
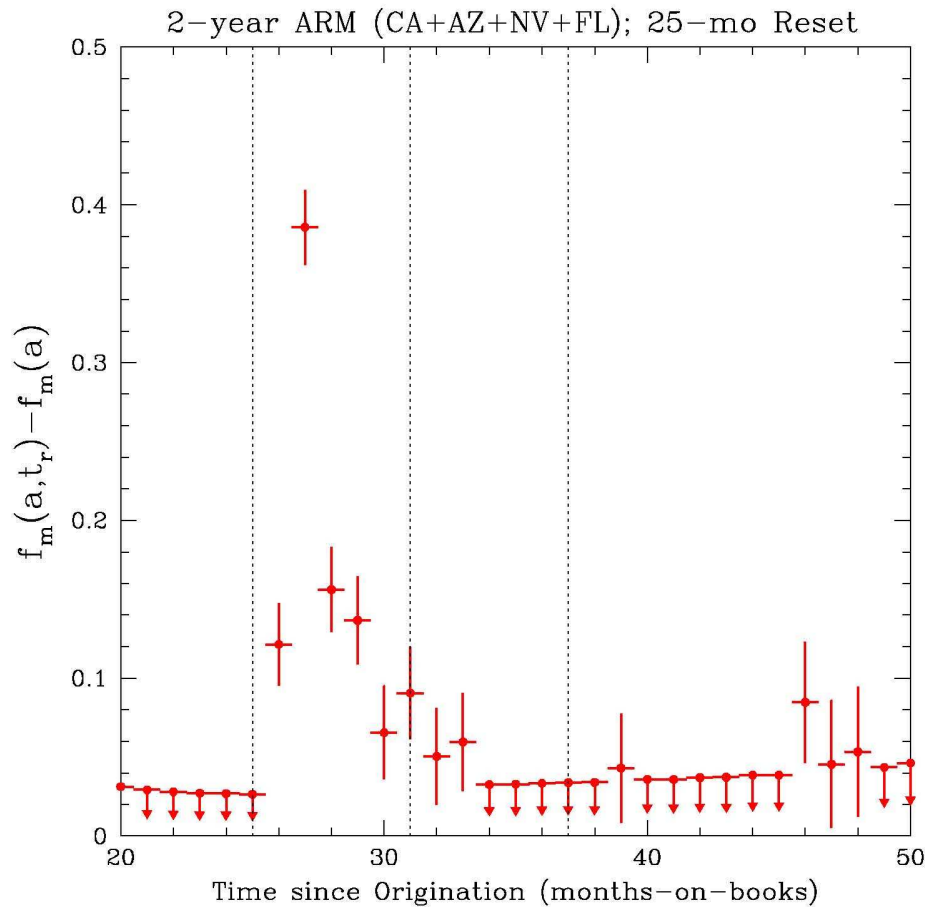
- A comparison of 60-89 DPD Account Rate maturation curves for a typical 2-year ARM and 5-year ARM loan portfolios. The initial interest rate reset times are shown with dotted lines.

# Adjustable Rate Mortgages: 2-yr ARM Maturation



- A month-on-books view of 60-89 DPD Account Rate performance curves for 2-yr ARM originated in California, Arizona, Nevada and Florida with initial rate reset occurring at 25 and 26 months (shown with dotted lines).

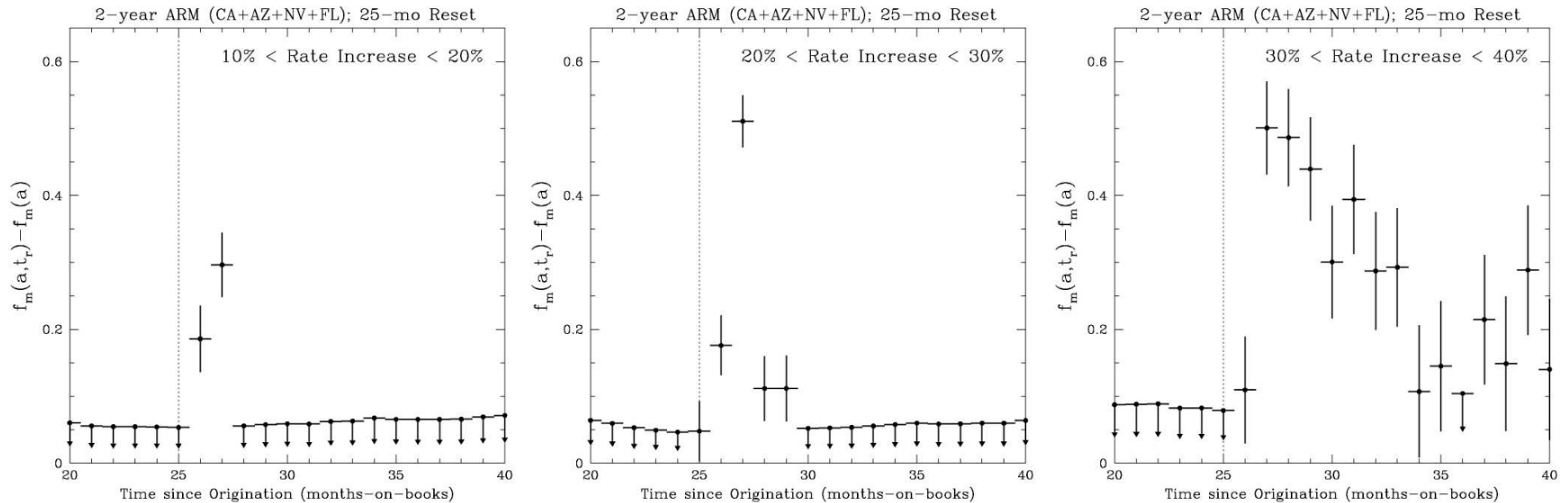
# Mortgage Rate Reset Response Estimation



- The Reset Response was estimated by extracting the contribution of the one-dimensional maturation component,  $e^{f_m(a)}$  from the total maturation curve,  $e^{f_m(a, t_r)}$ :

$$\text{Reset Response} = \ln(e^{f_m(a, t_r)} / e^{f_m(a)}) = f_m(a, t_r) - f_m(a)$$

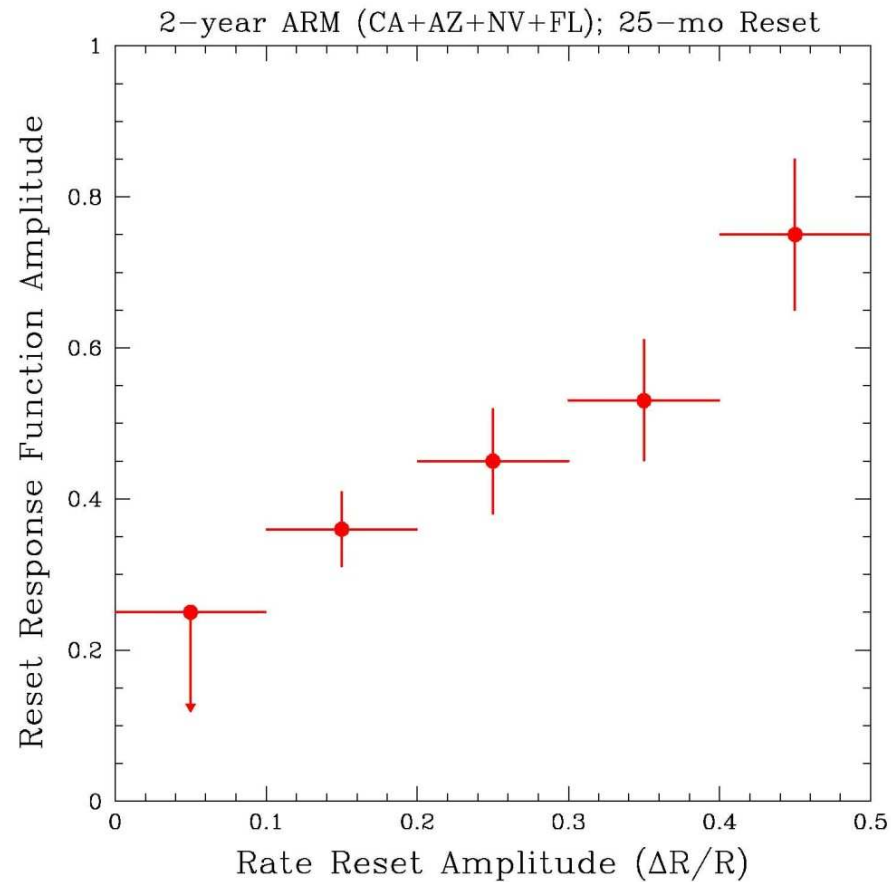
# Reset Response vs. Magnitude of Rate Reset



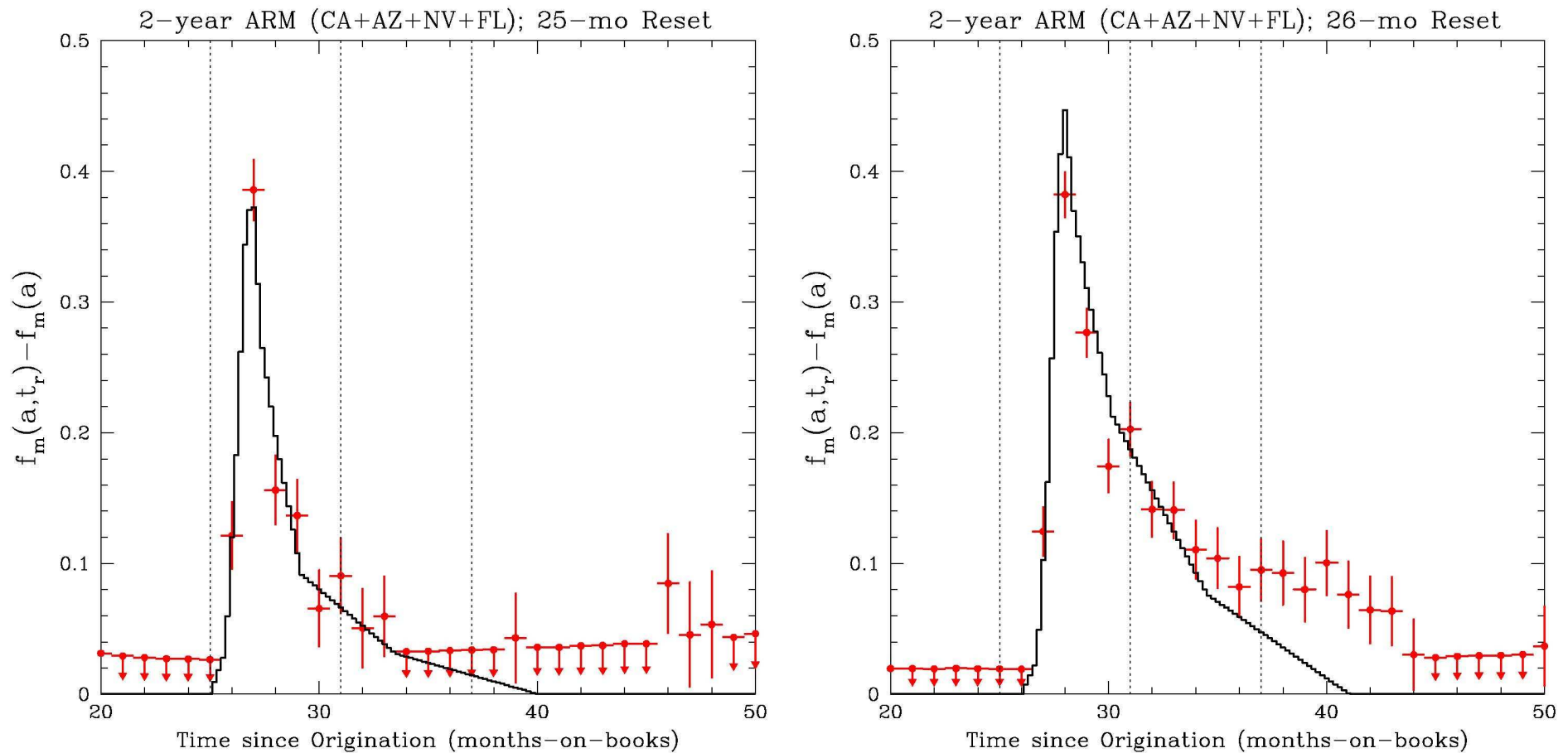
- The estimated Reset Response as a function of the magnitude of the interest rate reset for 2-year ARM loans originated in California, Arizona, Nevada and Florida.

# Calibrated Reset Response Function

- The Reset Response,  $f_m(a, t_r) - f_m(a)$  was modeled with triangular-shape linear function.
- The amplitude and characteristic width of the Reset Response function,  $\lambda f_r(t_r)$  is strongly correlated to the relative amplitude of the interest rate change,  $(\Delta R / R)$ .



# Predicting Reset Response Function



- A comparison of the predicted Reset Response functions vs. actual data for a sample of 2-year ARM loans originated in California, Arizona, Nevada and Florida. The model was built using calibrated response functions and individual loan-level information (initial interest rate, rate change etc.)

# Conclusions

- The term of the loan and the relative amplitude of the initial interest rate change are the two main parameters determining the response of the consumer to the mortgage rate reset.
- There is a significant difference in the shape of the mortgage reset response functions across product types and consumer groups.
- The amplitude and shape of the reset response function are highly correlated to the relative amplitude of the initial interest rate change.
- Application of the Dual-Time Dynamics methods allows to construct calibrated rate reset response functions for various products and consumer groups, given a specific interest rate scenario.
- Combined with one-dimensional maturation curve common to all vintages, the calibrated rate reset response function can be used directly in delinquency and loss forecasting on both account and vintage levels.