**Appendix C: The Test for the Endogeneity**

To test for the endogeneity we extended the approach proposed by Naik and Tsai (2000) to the non-linear models. We test for the measurement error in the contributions of the Mozilla Add-on Organization (AMO), and in the smoothed effects of new releases of Mozilla platform and its complements. Importance of accounting for measurement error in AMO contribution process raises not only in estimation, but also in suboptimal solution convergence, as proposed by Naik and Tsai (2000). To test for measurement error in AMO contribution process, first we model AMO process as a first order Markov chain with drift and stochastic error term. Then we extend it to model the supply side decision driven by length of AMO nomination queue. More formally in the first step we assume:

(E1)

where  denotes the observed AMO contribution level, and denotes latent AMO contribution level, and are parameters to estimate. In the second step we change state equation of latent AMO contribution level as following:

 (E2)

We can rewrite these models in the form of a state space form formally as:

 (E3)

(E4)

 (E5)

(E6)

 (E7)

To estimate these models we use a two-step approach. In the first step conditional on latent AMO contribution, and error distribution (), we estimate  using Extended Kalman Filter. Then in the second step conditional on we use (E4) as observation equation, and (E5) as state equation, and (E6) as the joint variance to estimate latent AMO contribution. The result of this estimation for both models is presented in the following table:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Model | Estimate | Mean | STD | 2.5% | 97.5% |
| Model 1 | Corr | 0.014 | 0.126 | -0.198 | 0.223 |
|  |  | 0.0005 | 0.005 | -0.007 | 0.008 |
| Model 2 | Corr | -0.002 | 0.115 | -0.195 | 0.193 |
|  |  | -3.5e-5 | 0.005 | -0.008 | 0.008 |

The correlation and the off diagonal elements of var-covar matrix estimation suggest that there is no measurement error.

To test for endogeneity of the smooth version of new release of Mozilla platform and its add-ons, we used the same approach. In particular we model new release of platform and its add-ons as separate first order Markov chain with drift and stochastic error term. In this case our state equation for each add-on consists of two equation, one smoothed release effect of platform for specific add-on and the other smoothed release effect of the add-on. Our second stage of estimation in this case uses 3 observation equations, the first two equation relate the observed smoothed effect with unobserved effect of new releases, and the third equation relates latent diffusion level to the unobserved effect of new releases. Following table presents the results confidence interval:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Corr | | Corr | |  | |  | |
| Add-on | 2.5% | 97.5% | 2.5% | 97.5% | 2.5% | 97.5% | 2.5% | 97.5% |
| 1 | -0.1012 | 0.0001 | -0.1033 | 0.0139 | -0.0004 | 0.0000 | -0.0003 | 0.0000 |
| 2 | -0.0324 | 0.0320 | -0.0332 | 0.0454 | -0.0002 | 0.0001 | -0.0001 | 0.0001 |
| 3 | -0.0951 | 0.0309 | -0.0829 | 0.0623 | -0.0001 | 0.0000 | -0.0003 | 0.0001 |
| 4 | -0.0001 | 0.0000 | -0.0002 | 0.0001 | -0.0603 | 0.0216 | -0.0437 | 0.0378 |
| 5 | -0.0738\* | -0.0024\* | -0.0172 | 0.0592 | -0.0002 | 0.0000 | -0.0001 | 0.0001 |
| 6 | -0.112\* | -0.001\* | -0.051 | 0.049 | -8.e-5\* | -3.e-5\* | -0.0001 | 0.0001 |
| 7 | -0.038 | 0.042 | -0.037 | 0.042 | -0.0001 | 0.0001 | -0.0001 | 0.0001 |
| 8 | -0.054 | 0.025 | -0.024 | 0.063 | -0.0001 | 0.0000 | -0.0001 | 0.0001 |
| 9 | -0.023 | 0.037 | -0.046 | 0.032 | -0.0001 | 0.0001 | -0.0002 | 0.0001 |
| 10 | -0.034 | 0.035 | -0.042 | 0.042 | -0.0001 | 0.0001 | -0.0001 | 0.0001 |
| 11 | -0.063 | 0.028 | -0.024 | 0.070 | -0.0002 | 0.0000 | -0.0002 | 0.0002 |
| 12 | -0.009 | 0.090 | -0.059 | 0.034 | -0.0001 | 0.0001 | -0.0002 | 0.0001 |
| 13 | -0.060 | 0.041 | -0.041 | 0.060 | -0.0002 | 0.0001 | -0.0001 | 0.0001 |
| 14 | -0.092 | 0.006 | -0.025 | 0.067 | -0.0004 | 0.0001 | -0.0002 | 0.0002 |
| 15 | -0.041 | 0.034 | -0.015 | 0.057 | -0.0001 | 0.0000 | -0.0001 | 0.0001 |
| 16 | -0.0888 | 0.0250 | -0.0381 | 0.0690 | -0.0003 | 0.0000 | -0.0002 | 0.0002 |
| 17 | -0.0904 | 0.0387 | -0.0360 | 0.0518 | -0.0003 | 0.0001 | -0.0001 | 0.0001 |
| 18 | -0.0599 | 0.0423 | -0.0690 | 0.0474 | -0.0004 | 0.0002 | -0.0003 | 0.0002 |
| 19 | -0.0865 | 0.0402 | -0.0789 | 0.0490 | -0.0005 | 0.0002 | -0.0005 | 0.0002 |
| 20 | -0.0699 | 0.0325 | -0.0435 | 0.0520 | -0.0002 | 0.0001 | -0.0001 | 0.0001 |
| 21 | -0.061 | 0.032 | -0.040 | 0.055 | -0.0002 | 0.0001 | -0.0001 | 0.0001 |
| 22 | -0.074 | 0.024 | -0.038 | 0.061 | -0.0002 | 0.0001 | -0.0001 | 0.0001 |
| 23 | -0.273\* | -0.115\* | -0.084 | 0.039 | -0.0002 | -0.0001 | -0.0003 | 0.0001 |
| 24 | -0.132\* | -0.010\* | -0.063 | 0.049 | -0.0003 | 0.0000 | -0.0004 | 0.0002 |
| 25 | -0.097 | 0.017 | -0.066 | 0.048 | -0.0004 | 0.0001 | -0.0004 | 0.0002 |
| 26 | -0.020 | 0.054 | -0.016 | 0.057 | -0.0001 | 0.0001 | -0.0001 | 0.0001 |
| 27 | -0.094 | 0.049 | -0.059 | 0.075 | -0.0002 | 0.0000 | -0.0002 | 0.0001 |
| 28 | -0.051 | 0.028 | -0.014 | 0.075 | -0.0002 | 0.0001 | -0.0001 | 0.0001 |
| 29 | -0.081 | 0.017 | -0.037 | 0.055 | -0.0001 | 0.0000 | -0.0001 | 0.0001 |
| 30 | -0.083 | 0.008 | -0.026 | 0.074 | -0.0001 | 0.0000 | -0.0001 | 0.0001 |
| 31 | -0.060 | 0.024 | -0.030 | 0.056 | -0.0001 | 0.0000 | -0.0001 | 0.0001 |
| 32 | -0.081 | 0.017 | -0.060 | 0.023 | -0.0001 | 0.0000 | -0.0002 | 0.0000 |
| 33 | -0.010 | 0.047 | -0.068 | -0.007 | -0.0001 | 0.0001 | -0.0002 | 0.0000 |
| 34 | -0.118 | 0.082 | -0.110 | 0.099 | -0.0008 | 0.0004 | -0.0008 | 0.0004 |
| 35 | -0.043 | 0.055 | -0.058 | 0.049 | -0.0001 | 0.0000 | -0.0002 | 0.0001 |
| 36 | -0.081 | 0.045 | -0.072 | 0.057 | -0.0003 | 0.0001 | -0.0003 | 0.0001 |
| 37 | -0.047 | 0.037 | -0.034 | 0.055 | -0.0001 | 0.0001 | -0.0001 | 0.0001 |
| 38 | -0.060 | 0.022 | -0.005 | 0.077 | -0.0001 | 0.0000 | -0.0001 | 0.0001 |
| 39 | -0.043 | 0.037 | -0.023 | 0.059 | -0.0001 | 0.0000 | -0.0001 | 0.0001 |
| 40 | -0.094 | 0.052 | -0.087 | 0.060 | -0.0006 | 0.0003 | -0.0004 | 0.0002 |
| 41 | -0.069 | 0.015 | -0.017 | 0.072 | -0.0001 | 0.0000 | -0.0001 | 0.0001 |
| 42 | -0.091 | 0.014 | -0.049 | 0.061 | -0.0001 | 0.0000 | -0.0001 | 0.0001 |
| 43 | -0.063 | 0.116 | -0.098 | 0.064 | -0.0005 | 0.0005 | -0.0005 | 0.0002 |
| 44 | -0.084 | 0.026 | -0.061 | 0.028 | -0.0003 | 0.0001 | -0.0002 | 0.0001 |
| 45 | -0.058 | 0.022 | -0.035 | 0.047 | -0.0001 | 0.0000 | -0.0001 | 0.0001 |
| 46 | -0.037 | 0.044 | -0.030 | 0.064 | -0.0002 | 0.0001 | -0.0001 | 0.0001 |
| 47 | -0.102 | 0.032 | -0.073 | 0.049 | -0.0005 | 0.0001 | -0.0004 | 0.0002 |
| 48 | -0.062 | 0.037 | -0.036 | 0.060 | -0.0002 | 0.0001 | -0.0001 | 0.0001 |
| 49 | -0.045 | 0.030 | -0.012 | 0.072 | -0.0001 | 0.0000 | -0.0001 | 0.0001 |
| 50 | -0.075 | 0.026 | -0.042 | 0.069 | -0.0002 | 0.0000 | -0.0001 | 0.0001 |
| 51 | -0.1052 | 0.0038 | -0.0665 | 0.0390 | -0.0004 | 0.0000 | -0.0003 | 0.0001 |
| 52 | -0.1080 | 0.0150 | -0.0760 | 0.0453 | -0.0003 | 0.0000 | -0.0004 | 0.0002 |

The correlation and the off diagonal elements of var-covar matrix estimation suggest that there is no significant measurement error.