Computational and Data Appendices for "Factor Utilization and the Real Impact of Financial Crises"

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A Mexican data appendix

This appendix describes how we construct empirical counterparts for theoretical variables with Mexican data. We use quarterly data when available, and impute quarterly series from yearly series otherwise.

Our sample goes from 1980.1 to 2003.1 regarding national accounts. Data from original sources are seasonally adjusted using the Census Bureau's X12-Arima procedure. All data are in 1993 prices. The following quarterly series are available from Mexico's Instituto Nacional de Estadística, Geografía e Informática (INEGI) and Mexico's Central Bank (detailed sources are available upon request):

1. Gross Domestic Product (GDP)
2. Gross Fixed Capital Formation, private (GFCFp)
3. Gross Fixed Capital Formation, public (GFCFg)
4. Change in inventories (CH)
5. Private Gross Capital Formation (GCFp)=GFCFp+CH
6. Gross Capital Formation=GCFp+GFCFg
7. Purchases of durable goods by households.

In order to make GDP from national accounts consistent with output in our model, we need to construct a few more quarterly variables: Indirect business taxes (IBT), the returns to government capital, and the returns to and depreciation of the stock of durable goods. IBT data are available from INEGI only at a yearly frequency, and we use yearly ratios (relative to GDP) to impute quarterly data.

Using data on private and public investment, and purchases of durable goods, we construct three capital stock series using the perpetual inventory method.[1] We assume a yearly depreciation rate of 6% for private capital, 5% for government capital and 20% for durable goods. To construct the total stock of capital, we add up the three resulting series. The average yearly depreciation rate implied by the total stock of capital, total investment and the law of motion of capital in the benchmark model is 8%. To calculate gross returns to government capital and the stock of durables we assume a net yearly return of 4% and the same depreciation rates as above.

After constructing these variables, we calculate the data counterpart of output in our model by subtracting from GDP indirect business taxes, and adding the imputed returns and depreciation of government capital and durable goods. To calculate per capita variables we use the yearly series for population of age 15 to 64 reported in Bergoeing, Kehoe, Kehoe and Soto (2002). To construct quarterly working age population, we take yearly growth rates of population and calculate implicit quarterly rates.

We also need an empirical counterpart for the labor input in the model. To that end, we first calculate (seasonally adjusted) average hours worked in the manufacturing sector from Mexico's Manufacturing Sector Survey available from INEGI. The survey produces monthly series for man-hours and for employment. There are two versions of the survey. The first one has data from 1987.01 to 1995.12. The second one has data starting in 1994.01. We splice the quarterly hours per employee of the two surveys. To calculate a measure of workers relative to total working age population, we multiply quarterly measures of the ratio of economically active population relative to population of age 12 and higher by the employment rate. These data are available from INEGI. The measure of the labor input per working age person consistent with the model is hours per employees times the ratio of employed persons to population. We scale the resulting series by 1300, an approximation of the total number of hours of discretionary time available in a quarter.

We use data on hours worked in the manufacturing sector since no other quarterly measure of hours exists for the time period we consider. On the other hand, one can use social security records to produce a different employment time-series.[2] The resulting employment measure falls more (6.7% vs. 1.2%) and produces a smaller drop in TFP in 1995 than in our benchmark data. This, in turn, reduces the gap between the predictions of our benchmark model and Mexican data. However, IMSS data paint a highly biased picture of the behavior of employment in Mexico. Workers who contribute to the social security system represent a small fraction of the labor force in Mexico and the share of formal employment is highly procyclical. In addition, employment in some sectors displays large fluctuations in the time period we study, probably due to changes in methodology (e.g. construction in 1997).

Finally, we now describe the construction of the business sector energy use index to which

[1] We assume that gross capital formation data includes the empirical counterpart of theoretical adjustment costs. In our simulations, adjustment costs amount to at most 1.7% of GDP in the benchmark model in any given period.

[2] The source is *Instituto Mexicano del Seguro Social*. We downloaded data available from IMSS at www.cefp.gob.mx.

we refer in the factor hoarding section of our paper. Quarterly energy consumption data come from INEGI.[3] Consumption by the non-energy producing sector for *gas licuado* (LPG), *combustóleo* (fuel oil), diesel, and *gasolina* (gasoline) are internal sales (*ventas internas*) plus imports into Mexico. We use weights inferred from annual consumption data available from the *Secretaría de Energía* (SENER) to subtract consumption by the residential and public sectors from our total energy consumption series. Quarterly electricity data from INEGI include only the industrial sector. We used annual industrial electricity consumption as a percentage of total business sector consumption from SENER to impute consumption by the rest of the business sector. All the series were converted to megajoules.

B Computational appendix

Benchmark model

Simple manipulations of first-order conditions for profit and utility maximization show that output can be reduced to a function of capital, so that equation (3) is a second order difference equation in capital only. We assume that after the first quarter of 2003 all exogenous variables stay forever at their level in the first quarter of 2003. Given k_0, we look for the unique k_1 such that the economy eventually converges to steady state via a standard shooting algorithm. All endogenous variables can then be calculated as a function of the path of physical capital. In the perfect surprise (PS) experiment, the algorithm is re-started in the first quarter of 1995 using as initial value for capital the value agents would choose under the expectations assumed before 1995.

Standard utility function

Given parameter values and paths for exogenous shocks, the algorithm we use consists of the following steps:

1. Guess a_0, the initial stock of risk-free bonds held by households.
2. Guess $\frac{c_0}{y_0}$ and calculate n_0. Since k_0 is known, y_0 can be calculated using the definition of output. So then can c_0.
3. Get c_1 from equation (4).
4. Guess k_1 and get y_1 and n_1 using equation (6) and the definition of output.
5. For $t \geq 0$ obtain c_{t+2} and k_{t+2} inductively by repeating steps 2 and 3.
6. Iterate on k_1 until capital converges to its steady state value.
7. Update $\frac{c_0}{y_0}$ until path for assets is stable.

[3] In the process of producing these data, we discovered several errors in the electricity series published by INEGI, including the fact that they did not reflect the effects of major tariff changes in 1992. We are most grateful to Rafael del Villar from Banco de México and Jorge Garcia Peña from CFE for helping us construct the correct series. INEGI has now updated and corrected its series.

8. Update a_0 until the debt-GDP ratio predicted by the model for 1994 is 35%, as in the data.

Capital utilization

The model produces the same second order difference equation for capital as before, except that output and depreciation now depend on utilization. But utilization is a function of the capital-output ratio (see equation 7). Therefore, equation (3) can be written as a second order difference equation in capital only as in the benchmark model, and the same shooting algorithm can be used.

Labor hoarding

The algorithm is very similar to the previous one. We have shown that effort is a function of the output per hour ratio. This is function (8). We have to add a static equation to find the value of n_t, each period. This equation is (C.6) in the description of the solution of the model in Appendix C. We use the fact that output y_t can be reduced to a function $f(k_t, n_t)$ of capital and employment. Finally, (3) can be written as a second order difference equation in capital only as in the benchmark model.

C Labor hoarding model

Assume as in the text that households maximize:

$$\sum_{t=0}^{+\infty} \beta^t \left[l_t \log \left(c_t^e - \kappa - \frac{1}{\nu} (f \epsilon_t)^\nu \right) + (1 - l_t) \log (c_t^u) \right]$$

where ϵ_t is effort at date t, l_t is the probability that a household becomes employed, c_t^e is consumption if the household is employed, and c_t^u is consumption if the household is unemployed. Letting w_t be the price of labor services, households face the following budget constraint:

$$\left(l_t c_t^e + (1 - l_t) c_t^u \right) (1 + \tau_t^c) + k_{t+1} + a_{t+1}$$

$$= l_t f \epsilon_t w_t \left(1 - \tau_t^l\right) + a_t (1 + r_t \left(1 - \tau_t^k\right)) + k_t (1 + r_t^k \left(1 - \tau_t^k\right)) - \frac{\psi}{2} (k_{t+1} - k_t)^2 - \frac{\psi_l}{2} \left(l_t - \bar{l}\right)^2 + T_t.$$

In Hansen (1985) or Rogerson (1988), it is optimal for agents to equate consumption across employment states. In our model this is not the case. It remains true however that households equate utility across employment states at all dates t:

$$c_t^e - \kappa - \frac{1}{\nu} (f \epsilon_t)^\nu = c_t^u, \tag{C.1}$$

which implies that employed households consume more than unemployed households. Similarly, utility maximization by households implies that at date t employment and effort solve:

$$
\begin{aligned}
f\epsilon_t w_t(1-\tau_t^l) &= (c_t^e - c_t^u)(1+\tau_t^c) + \psi_l(l_t - \bar{l}) && \text{(C.2)}\\
(f\epsilon_t)^\nu &= f\epsilon_t \frac{w_t(1-\tau_t^l)}{1+\tau_t^c}. && \text{(C.3)}
\end{aligned}
$$

On the other hand, profit maximization by firms implies:

$$
w_t = \frac{\alpha_n y_t}{n_t f \epsilon_t}. \tag{C.4}
$$

Equations (C.1-C.4), the fact that n_t must equal l_t in all periods, and some algebra imply the following condition for effort for all t:

$$
\epsilon_t = \left(\frac{\alpha_n (1-\tau_t^l) y_t}{(1+\tau_t^c) n_t f^\nu} \right)^{\frac{1}{\nu}}. \tag{C.5}
$$

Finally, first order conditions for profit maximization together with equations (C.1-C.4) yield the following equation for employment:

$$
(1-\tau_t^l)\left(1-\frac{1}{\nu}\right)\alpha_n \frac{y_t}{n_t} = \psi_l(n_t - \bar{n}) + \kappa(1+\tau_t^c). \tag{C.6}
$$

We can then easily show that output y_t at date t can be reduced to an increasing function of capital and employment so that the above equation can be solved uniquely for n_t given k_t. All told therefore, the model boils down once again to a second order difference equation in capital alone which we can simulate using the same shooting algorithm as before.