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Money and Productive Efficiency

Evidence from a High-Inflation Country

Abstract: *This paper examines how money balances held by manufacturing firms affect their efficiency in generating sales revenue in a high-inflation economy. The analysis employs data from Turkish firms to estimate a stochastic frontier model, finding a strong positive association between the firms' money holdings and their efficiency. However, the role of money balances seems to diminish as firms hold higher raw material inventories.*

Key words: *high inflation, inventories, manufacturing, money demand by firms, stochastic frontier estimation, Turkey.*

The observation that firms holding real money balances improve their efficiency in production is not new; both empirical and theoretical studies have made considerable contributions.[1] Nevertheless, the questions as to why firms hold cash balances, and what the exact role of money in production is—whether directly included in the production function as a factor input, or indirectly affecting the efficiency of production—are still open to discussion. Regardless of the precise channel of money's utility in the production process, it is natural to expect that firms operating in a high-inflation environment cut back their demand for money. The oppor-

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tunity cost to firms of holding noninterest-bearing cash balances would be substantially high in an economy with annual inflation rates between 50 to 100 percent. Hence, we readdress the issue in an empirical framework for the Turkish economy, which has a history of chronic high inflation.[2]

Our basic theoretical attempt to explain the behavior of firms in Turkey rests primarily on the precautionary motive of money demand by firms. We argue that one of the possible reasons why firms hold low interest–bearing liquid assets, under inflationary conditions, is uncertainty about business conditions that can be resolved only after firms make their portfolio choices. This uncertainty may be about relative input prices, demand conditions, machine breakdowns, or timing of cash flows (Baum et al. 2004), among other reasons.

In cases of relative input price uncertainty, firms that hold more cash balances are better situated to benefit from surprise falls in input prices.[3] Similarly, in cases of demand uncertainty in a monopolistic sticky-price model of the firm, liquid firms can produce and sell more under favorable demand shocks. Finally, in cases of unexpected machine breakdowns, relatively cash-rich firms may ensure smooth production and sales.

The idea can also be formalized in a competitive setting, such as under limited participation models (e.g., Barth and Ramey 2001; Başçı and Saglam 2005; Christiano et al. 1997, 1998; Fuerst 1992), which illustrate the importance of working capital to production and efficiency. The abovementioned factors of input-price uncertainty, favorable and unfavorable demand shocks, and machine breakdowns add to the need for holding working capital. That is, though working capital is usually associated with the totally anticipated (e.g., routine) operations of a manufacturing organization, unanticipated factors could create further demand for such capital. In short, in an environment of high inflation, though one would expect firms to hold less money due to the increased opportunity costs of holding cash, it is also reasonable to expect an increase in their precautionary demand for money, due to the reasons mentioned earlier.

The empirical literature on firms' money demand mostly includes real money balances as a factor input in a production-function framework. Some papers study firms' demand for money in countries with low or moderate inflation (Dennis and Smith 1978; Hasan and Mahmud 1993; Nadiri 1969; Simos 1981; Sinai and Stokes 1972). The question as to why money should appear in the production function has given rise to a theoretical literature as well. Papers with microefficiency explanations (Fischer 1974; Friedman 1969; Harkness 1984; Jansen 1985; Saygili 2005) and macroefficiency explanations emphasize that money by itself is not a genuine component of the physical production function, but is only a proxy for other services.[4] More recent empirical studies model money as an outside variable that affects productive efficiency (Delorme et al. 1995; Nourzad 2002). Nevertheless, to the best of our knowledge, there is no study of the link between money and efficiency in a high-inflation country. This paper attempts to fill the gap.

We study data from a sample of Turkish firms during a highly inflationary episode. In line with the traditional modeling approaches, we use the stochastic frontier approach. Assuming that the workings of the engineering production function and associated efficiency effects are separable, we estimate these separated functions and interpret our findings regarding the effects of money and raw material inventories on the measured efficiency.

We observe that despite high and persistent inflation, manufacturing firms hold considerable cash balances, which are dispersed considerably across firms. Using a stochastic frontier framework for the Turkish manufacturing industry, we find a strong positive relation between holding money balances and the ability to generate sales revenues, in line with Delorme et al. (1995) and Nourzad (2002). We further note that the relation between money balances and the ability to generate revenue weakens with increasing raw-material inventories.

The Data

The data are compiled from the company balance sheets reported by the Istanbul Stock Exchange.[5] The variables that we consider are the end-of-year accumulated gross sales revenue, measured in nominal trillions of Turkish lira (Y); capital (K), measured as the current value of fixed structure and machinery measured in nominal trillions of lira at the end of the year; labor (L), measured as the total number of employees at the end of each year; raw materials (N), measured in nominal trillions of lira at the beginning of each year; beginning-of-year total demand deposits (DD) of a firm, in trillions of lira; and beginning-of-year total short-term credits (STC) of a firm, in trillions of lira.

Regarding the effect of inflation on average cash holdings, Table 1 shows the ratios of various liquidity measures as a fraction of total assets. The ratios of liquid assets—basically, cash and marketable securities—to total assets for our sample are comparable to those in the United States as reported by Baum et al. (2004).[6] The descriptive statistics of variables used in estimating the empirical model are provided in Table 2.

Stochastic Frontier Estimation

This section estimates the production and stochastic inefficiency functions for the Turkish manufacturing firms considered. Our empirical strategy is to test the role and significance of real money balances in the abilities of manufacturing firms to generate sales revenue. In the stochastic frontier approach—independently proposed by Aigner et al. (1977) and Meeusen and van den Broeck (1977)—the residuals from a production function are separated into two different components. One component captures the variation in sales revenue due to factors that are not under the control of the firm; the other represents the influence of pure technical-efficiency variables. In our estimation strategy, we link the technical inefficiency component to money balances.[7]

Table 1

Selected Asset Ratios

	Demand deposits/ current assets	Demand deposits/ total assets	Total liquidity/ current assets	Total liquidity/ total assets
		1999		
Mean	7.430	4.571	13.580	8.233
Median	2.542	1.437	6.544	3.698
Standard deviation	10.081	6.373	15.681	9.740
Skewness	1.800	1.728	1.401	1.494
Kurtosis	5.885	5.052	4.170	4.751
Minimum	0.006	0.004	0.043	0.029
Maximum	48.119	26.111	66.121	47.702
Count	144	144	144	144
		1998		
Mean	6.929	4.288	15.403	9.592
Median	2.201	1.275	6.369	4.239
Standard deviation	11.350	7.127	17.568	11.615
Skewness	2.745	2.836	1.211	1.442
Kurtosis	11.002	11.986	3.478	4.266
Minimum	0.006	0.004	0.085	0.051
Maximum	60.987	39.440	74.533	49.190
Count	129	129	129	129

Source: Company balance sheets by the Istanbul Stock Exchange; authors' calculations.
Note: The primitive ratios are multiplied by 100 for ease in visualization.

The stochastic production frontier technique, initially introduced for estimating technical efficiency using cross-sectional firm data, has been extended in various ways regarding both specification and estimation (see, e.g., Greene 1993 for a recent survey of the frontier model literature). The efficiency effects model of Battese and Coelli (1995) is such an extension, where the objective is to estimate simultaneously the parameters of the stochastic production frontier and the significance of the variables that are hypothesized to affect the levels of efficiencies in production. To describe the model, let

$$Y_i = f\left(x_i, \beta\right) e^{V_i - U_i} \quad (1)$$

Table 2

Descriptive Statistics of Data

	Y	*K*	*L*	*N*	*DD*	*LQ*	*STC*
			1999				
Mean	45.5	19.5	839.8	1.7	1.2	2.4	3.9
Median	21.1	8.8	506.0	0.8	0.2	0.5	2.0
Standard deviation	73.7	42.7	1,053.1	3.7	3.0	4.6	6.1
Skewness	4.4	6.7	3.2	7.3	4.6	2.8	3.4
Kurtosis	25.7	55.9	12.7	67.3	24.4	8.3	14.4
Minimum	0.5	0.1	15.0	0.0	0.0	0.0	0.0
Maximum	605.4	418.9	6,395.0	37.8	22.4	23.8	40.9
Count	144	144	144	144	144	144	144
			1998				
Mean	32.7	15.0	906.8	1.4	0.9	2.4	2.2
Median	15.7	5.8	571.0	0.6	0.1	0.2	0.8
Standard deviation	46.8	42.0	1,091.5	2.8	3.1	7.6	3.5
Skewness	3.1	6.8	3.2	6.4	8.4	7.2	3.9
Kurtosis	11.2	50.5	12.0	50.7	82.1	62.3	20.1
Minimum	1.0	0.1	16.0	0.0	0.0	0.0	0.0
Maximum	288.4	364.3	6,828.0	26.4	32.2	73.8	25.6
Count	129	129	129	129	129	129	129

Notes: All monetary quantities are quoted in trillions of Turkish lira; labor is reported as number of employees. LQ = liquid assets, which are composed of cash and marketable securities. It refers to the same quantity as Total Liquidity in Table 1.

be a stochastic production frontier, where Y_i represents the production for the ith firm; $f(x_i, \beta)$ is a suitable function of a vector x_i of factor inputs associated with the production of the ith firm; and β is a vector of unknown parameters. Values of V_i are assumed to be identically and independently distributed with $N(0,\sigma_V^2)$, and U_i is assumed to be a random variable that is independently distributed as truncations at zero of a normal distribution with mean μ_i and variance σ_U^2, $\mu_i = g(z_i, \delta)$. Here, z_i is a vector of variables that may influence the efficiency of a firm, δ is a vector of parameters to be estimated, and $g(.)$ is usually assumed to be linear. The parameters of the stochastic production frontier and coefficients of the technical efficiency effects can be simultaneously obtained by the maximum likelihood procedure, as shown by Battese and Coelli (1993). The likelihood function is expressed in terms of β, δ, and variance parameters $\sigma_s^2 = \sigma_V^2 + \sigma^2$ and $\gamma = \sigma^2/\sigma_s^2$.[8]

In our model, Y_i stands for the gross sales revenue of firm i instead of the amount of physical output, in line with the usual treatment in the earlier empirical literature (e.g., Delorme et al. 1995; Nourzad 2002). We estimate the translog specification of the stochastic frontier model, given by Equations (2) and (3) and estimated jointly, using the maximum likelihood procedure as shown by Battese and Coelli (1993). It is assumed that the technical inefficiency effect component is linear in its arguments:

$$\ln\left(Y_i\right) = \beta_0 + \sum_{j=1}^{3} \beta_j \ln\left(x_{ji}\right) + \frac{1}{2} \sum_{j \leq k}^{3} \sum_{k=1}^{3} \beta_{jk} \ln\left(x_{ji}\right) \ln\left(x_{ki}\right) + V_i - U_i \tag{2}$$

$$\mu_i = \delta_0 + \delta_1 DD_i + \delta_2 STC_i + \delta_3 \left(DD_i\right)\left(N_i\right) + W_i, \tag{3}$$

where the input vector *X* includes *K*, *L*, and *N*, and the vector *Z* consists of *DD*, *STC*, and the interaction of *DD* and *N*. The variables employed in estimating (2) and (3) have been explained above.

Table 3 reports the results. In all cases, we first test the restrictions imposed by the Cobb–Douglas production function. We were able to reject these restrictions using the log-likelihood ratio test at the 5 percent level of statistical significance. Therefore, we restrict our discussion of results to the translog specification of the model only.

In general, we conclude that money balances and short-term credit seem to affect the efficiency of manufacturing firms in generating sales revenue both positively and significantly. However, the results for 1999 are relatively more significant than they are for 1998. Furthermore, the interactive term between money and inventories turned out to be statistically significant for 1999 (Table 3). The results suggest that firms with larger inventories at the beginning of the year seem to gain less in increasing efficiency by holding more money balances. These results are consistent with the findings of Delorme et al. (1995) and Nourzad (2002), who, using aggregate macroeconomic data, find that money enhances efficiency, albeit for developed economies only.

By and large, the linear parameters of the stochastic frontier are significant. The three inputs have been normalized by their respective sample means before estimation, and therefore, the parameter estimates of the linear part are also output elasticities evaluated at respective sample means. The results imply decreasing returns to scale, with relatively higher output elasticity for capital input. The statistical significance of the parameters of the nonlinear part of the stochastic frontier is mixed.

Conclusion

This paper studies firms' money demand in a high-inflation environment. We observe that despite high and persistent inflation, Turkish manufacturing firms hold

Table 3

Estimated Model

	1998		1999	
Stochastic frontier				
Constant	0.571	0.725***	1.615***	0.617***
	(0.982)	(0.176)	(0.587)	(0.163)
ln*K*	0.383***	0.264***	0.268***	0.223***
	(0.088)	(0.090)	(0.059)	(0.098)
ln*L*	0.290*	0.091	0.333***	0.296***
	(0.165)	(0.124)	(0.079)	(0.118)
ln*N*	0.074	0.309***	0.006	0.276***
	(0.080)	(0.086)	(0.039)	(0.100)
$(\ln K)^2$		0.062		–0.007
		(0.073)		(0.081)
$(\ln L)^2$		0.228*		–0.092
		(0.138)		(0.139)
$(\ln N)^2$		0.058***		0.051**
		(0.015)		(0.024)
(ln*K*)(ln*L*)		–0.093		0.112*
		(0.081)		(0.062)
(ln*K*)(ln*N*)		–0.026		0.002
		(0.019)		(0.071)
(ln*L*)(ln*N*)		–0.077		–0.048
		(0.078)		(0.118)
Technical inefficiency model				
Constant	0.030	1.020***	1.559***	1.133***
	(0.220)	(0.308)	(0.257)	(0.219)
DD	–0.048	–0.255**	–0.256***	–0.176***
	(0.813)	(0.130)	(0.063)	(0.038)
STC	–0.051	–0.117**	–0.077***	–0.049***
	(0.118)	(0.056)	(0.025)	(0.019)
(*DD*)(*N*)	–0.001	0.007	0.008	0.011***
	(0.062)	(0.006)	(0.005)	(0.004)
σ^2	0.547*	0.532***	0.574***	0.426***
	(0.289)	(0.129)	(0.091)	(0.051)
γ	0.084	0.749***	0.462***	0.139
	(0.500)	(0.144)	(0.118)	(0.165)
Likelihood function	–140.643	–118.344	–152.692	–140.134

Source: Authors' calculations.

Notes: Standard errors are reported in parentheses under the corresponding estimated parameters. *, **, and *** indicate statistical significance at the 10, 5, and 1 percent levels, respectively.

a considerable amount of cash balances. One possible explanation, provided in this paper, is the high relative input-price uncertainty that comes with inflation. These empirical observations may also be compatible with a monopolistic model of the firm under demand uncertainty, and with the approach taken by Baum et al. (2004), under which money is demanded as a precaution against unexpected delays in receivables.

The empirical results of the stochastic frontier model suggest that the efficiency of firms in generating sales revenue is positively and significantly related to the firms' liquidity. Furthermore, the effect of higher liquidity on efficiency seems to decrease with increasing raw-material inventories.

Notes

1. The idea put forth by Feenstra (1986) showing the functional equivalence between liquidity costs in the budget constraint and money in the utility function has been recently implemented by Saygili (2005) on the relation between transaction costs and money in the production function. This study asserts that including money in the production function saves time and other resources that would otherwise be allocated to transaction services.

2. Ertugrul and Selcuk (2001) provide a brief history of the Turkish economy during the past two decades.

3. There is a well-established connection between the level of inflation and the relative price uncertainty in both developed (Domberger 1987; Parsley 1996) and emerging market economies (Caglayan and Filiztekin 2003).

4. In most of these studies, the underlying motive for holding cash balances is mostly associated with transaction demand for money.

5. The data are available at the official Web site of the Istanbul Stock Exchange (www.imkb.gov.tr/malitablo.htm).

6. Baum et al. (2004) report the average cash-to-asset ratio for all nonfinancial firms in their sample over the past forty-eight years as 11 percent. In our sample, this ratio is reported near 5 percent over the sample period.

7. Usual practice in the previous literature is to include the real money balances in the production function. Although many authors acknowledged the conceptual problem with this approach (Fischer 1974), there are very few studies that empirically distinguish the engineering production function from a sales revenue function (see, e.g., Sinai and Stokes 1972).

8. Once the parameters of the efficiency effects model are estimated using the maximum likelihood estimation procedure, technical efficiencies of each firm are obtained by the method proposed by Jondrow et al. (1982).

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