Regulation and the Market for Checks*

Semih Tumen †

University of Chicago

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Abstract

This paper analyzes the market for checks using the monopoly problem as an approximation. The need for such an analysis arises due to the following policy proposal: the Turkish government considers increasing the lump-sum amount that drawee banks are legally responsible to pay per bad check. We show that banks will tend to restrict the quantity of checks as a response to such a policy action. We report that a percentage increase in banks' obligation per bad check could lead up to a 1.7% decline in the total supply of checks on the margin. We establish that the extent of the monopoly distortion depends on three main factors: (i) the elasticity of demand for checks, (ii) how fast the fraction of bad checks increase with the total supply of checks, and (iii) the degree of preference heterogeneity.

JEL codes: D42, G28.

Keywords: Checks, regulation, monopoly power, preference heterogeneity.

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†semihtumen@uchicago.edu. 1155 E 60th S, Room 215A, University of Chicago, 60657, Chicago, IL.

1 Introduction

The severity of this recession and the seemingly successful regulatory efforts to remedy the damages of the initial shock have led to, sometimes ignorant, calls for substantial changes in the present regulations especially in the financial sector. We agree that new regulations are needed, but the type of new regulations must be in response to a recognition that market forces will determine how the effects of these regulations diffuse into the economy. This paper argues how one can think of the workings of the market for checks and how the market forces interact with certain regulatory efforts. We present a Turkish case study which exemplifies the illusive charm of trying to government control everything. Throughout this section, we describe the problem and motivate the idea that our analysis originates from.

Commercial life in the Turkish economy extensively draws on checks as a medium of exchange. Each year more than 30 million checks are processed by banks. Unlike the US economy and other modern economies where checks are used in all kinds of daily transactions, checks are almost exclusively used by merchants in the Turkish economy. This fact highlights the importance of regulatory practices and policy actions associated with the use of checks for the real economy, and, in particular, for small- and medium-scale enterprises who are substantially dependent on checks to ease out their liquidity needs.

Banks issue checks against some form of a collateral or promise.[1] Merchants use these checks in their transactions and the owner of the check has the right to cash out. Most of the time two parties informally agree on a future cash out date—typically up to 12 months—for a current transaction. The party who accepts the check bears the risk of not getting paid when she demands a cash out. When the economic outlook is positive, this is less of a concern. But when the economy goes down-the-road, sensitivity in risk perceptions increases and merchants become more careful in accepting checks. Checks are so widely used that seeking cash-only transactions would mean to lose an important fraction of customers. Moreover, checks are attractive for all parties since they offer a flexible borrowing instrument the terms of which are

[1] The form and the amount of collaterals demanded largely vary across banks though. The history of the relationship between the merchant and the bank is an important factor determining the amount of collateral.

decided bilaterally. Perhaps the most striking feature of checks is that they can be signed off to third parties for further circulation. There is no close substitute for checks offering similar benefits. But still, checks impose an exogenous risk on enterprises and this risk frequently leads to a debate over government regulation.

On the legal side, the issuer of the bad check is subject to severe punishments ranging from heavy fine to imprisonment up to 5 years. Still, Turkish courts review and adjudicate more than 200,000 cases related to bad checks every year. These impose significant costs on the parties involved in transactions that checks are used as the medium of exchange and also on the society. Besides this legal framework, there is a simple rule that the Central Bank of Turkey sets on behalf of the Turkish government: drawee banks are obliged to pay a certain lump-sum amount—say π (which is currently TRY 470, approximately USD 300)—to the check owners per bad check. In other words, the government decides on the extent of the *risk-sharing* between the check owner and the drawee bank. Table (1) shows the historical values for drawee banks' obligation, π, in both real and nominal terms.[2] To our knowledge, French and Polish governments impose similar requirements on drawee banks. However, their π is negligibly small and has no observed effect on the workings of the system. Obligatory payments currently impose a nonnegligible burden on the Turkish banking system. Each year these payments amount to a roughly 0.5% of the equity capital of the whole banking sector. It is worth mentioning that not every bad check goes through this process. Sometimes the bad check owners do not want to start legal proceedings since they would like to preserve their existing commercial links with their clients. If π goes up significantly, an increasingly higher burden would fall on the drawee banks since these goodwill motives would weaken.

The main motivation behind this paper is a recent policy debate: the Turkish government considers an at least twofold increase in π. A related but distinct proposal is to use π as a policy instrument in the future. The aim is to partly transfer the check owners' risk to drawee banks and, further, to establish a government control—as a policy tool—over the risk-sharing

[2] Magnitude of π is currently indexed to inflation and is regularly adjusted every year. The indexation started in 2003. The reason real π seems as if it visibly changes is that it is actually indexed to PPI and we use CPI as the deflator. PPI series has been published since 2003 and we choose to deflate with CPI since it offers a consistent series going back to 1985.

Year	π (TRY)	Real π (1995 = 100)
1985	0.02	216
1990	0.125	158
1993	0.5	135
1995	1.5	100
1997	5	110
2002	60	105
2003	300	416
2004	310	368
2005	350	389
2006	370	372
2007	410	375
2008	435	368
2009	470	363

Table 1: Drawee banks' obligation per bad check. Real π is calculated using the CPI series.

arrangements in the market for checks. The proposal seems innocuous in the sense that it is expected to serve as a partial insurance for the check owners and to provide a longer run stimulus for the banks to perform more efficient screening practices. However, screening is costly and requires a continuous investment in institutional (external and internal) auditing.

As a reaction to such an increase in π, banks will tend to exercise their monopoly power and restrict the number of checks they issue. This concern is of extreme relevance especially during recession periods like the one the world is currently experiencing. The widespread belief that the world economies are expected to undergo a sustained economic slowdown reinforces the monopoly power of the banks. When the state of the economy is not worrisome, such a policy change would not be a big deal. In fact, a fivefold nominal increase in π was executed in 2003 and the effects were not so frightening. But setting the effects of the policy change in 2003—when the economic outlook was positive—as a benchmark and trying to make policy predictions for the future based on this benchmark by analogy is not a sensible strategy and, ironically, such a viewpoint is the subject of the famous critique by Lucas (1976). As a response to the current policy debate, Turkish banks have raised their concerns and have signalled that they may restrict the supply of checks. This restriction is likely to operate through various channels and may result in nonnegligible effects on the level of economic activity—which is a major concern nowadays. One channel worth mentioning is the amount of collateral demanded by the drawee banks. By increasing collaterals, banks can impute the risk to the checkbook owners. Thus, only the best customers and the ones who agree to pay the increased collateral will own a checkbook.

From a macroeconomic stand point, this discussion relates to the supply of the so-called "inside money", i.e., the debt used as money. Net inside money should always add up to zero in an economy, but inside money is measured in gross terms, i.e., by the amount of liability to the issuer (the person who writes the check in our context). Checks make up a significant fraction of inside money in the Turkish economy. The facts that they circulate and can be signed off to third parties bring in a large multiplier effect. If banks restrict the supply of checks as a reaction to an increase in π, the volume of gross inside money in the economy would shrink and, in turn, the economic activity relying on checks (which is vast in Turkey) would likely slow down. Kiyotaki and Moore (2000) establish conditions under which the circulation of inside money is essential for the smooth running of the economy and define the "symptoms" of liquidity shortage. In a related work, Kocherlakota (1998) points out the committment issues resulting from bilateral agreements. See Lagos (2008) for an excellent review of the related literature.

The literature on checks and related payment systems issues is vast. However, a surprisingly small number of attempts have been made to incorporate checks into standard economic models. One example is He et al. (2005)—a version of Kiyotaki and Wright (1993)—which is a model of equilibrium search. Another is McAndrews and Roberds (1999). Most of these papers take either a monetary economics or a methodological payments systems approach. This paper differs from the others in that it brings in the law and economics components of the problem via analyzing the effects of altering the regulatory practices on equilibrium outcomes in the market for checks.

In this paper, we abstract from the theoretical issues that monetary economics deal with and, instead, we focus on a simple monopoly problem. Since banks are the sole suppliers of checkbooks and they have the ability to adjust the quantity of checks as a response to changing market conditions, we treat the banking sector as a single bank, the monopolist.[3]

[3] It sounds more reasonable to assume imperfect competition with many banks, but the returns from such a setup do not worth

The monopolist "sells" checks at the monopoly "price" and bears the total cost of producing checks: π times the number of bad checks that the monopolist makes payment for. Price of a check that we study in this paper is an abstract notion. (We call it the "implicit" price.) Loosely speaking, price of a check can be thought of as a composite of various pecuniary and nonpecuniary factors such as the opportunity cost of the collateral demanded by the drawee banks or the benefits and flexibilities that checks offer. When one talks about monopolies, a question that would naturally arise is: what happens to the monopoly rents? The standard answer is: other than the deadweight loss associated with the monopoly, there would be an additional loss resulting from the competition to become a monopolist (see Posner (1975)). Although we agree with this viewpoint, we abstract from it for the purpose of focusing on the primary policy implications.

Another issue that we abstract from is the political economy of the problem. The government (regardless of the name of the ruling party) will tend to be a proponent of such a policy change since the proposed regulation directly sends effective messages to the voter base. This is consistent with the "capture" viewpoint *à la* Stigler (1971) in the sense that interest groups will use their regulatory power to shape laws and political institutions in a way they think it is mutually beneficial to themselves and to the government. We do not address how strategic interactions between the government and voters affect the policy making process. Instead, this paper presents one example when a policy action aimed at making the target group happier can produce consequences that would eventually disappoint them.

The tendency among the analysts is to look at the results of the fivefold nominal increase in 2003 and to make inference by simple analogy or various regressions. This paper is constructed on the prior belief that the policy challenge that we currently face is different from the one that analysts and policy makers faced in 2003. How different the economic outlook is between macroeconomic episodes and how this difference affects the market for checks can clearly be seen in Figure (1.1). 2001 is a year of a serious currency crisis in Turkey. It is followed by, first, a consolidation period, and then a period of aggressive growth. Then comes the

the cost of algebraic complexity that would arise. Moreover, the monopoly problem yields, as we discuss in Sections 2, 3, and 4, easier-to-interpret and sharper results.

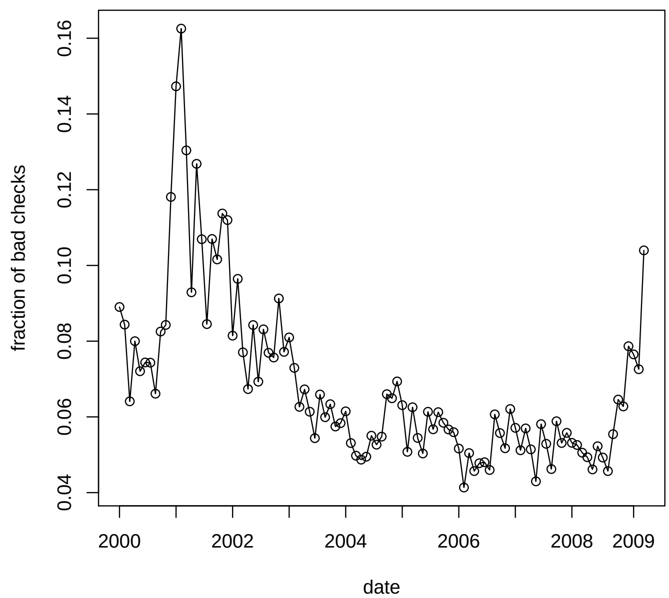

Figure 1.1: Fraction of bad checks.

recent downturn in 2008. Unlike the macroeconomic outlook in 2003, the likelihood of being exposed to a period of sustained economic inactivity is quite high today. Rather than trying to make policy inference using simple correlations, one has to focus on theorizing the potential behavioral outcomes of the parties affected by the proposed policy change. We do not say that econometric or descriptive statistical analyses are wrong nor harmful. When the data set is rich enough and carries sufficient information, regression outcomes would be a natural starting point for policy evaluation. But when there is inadequate information, like the present case, correlations would be misleading almost surely. For our problem, this inadequacy is twofold: (1) the data series we have starts at 2000, so there is only one data point representing a historical change in π, and (2) the data is aggregated across banks and it is impossible to keep track of bank- or group-specific effects. To characterize the banks' response as a reaction to the proposed policy change, we rely on a simple monopoly problem. This is a strong assumption, but it communicates what economics has to say on the current policy debate. We conjecture that the story in Figure (1.1) can be explained as a whole using a dynamic stochastic model. But such a setup is beyond the scope of this paper and we leave this task for future research.

The assumption of treating the banking sector as a single firm produces sharp and sensible results, but it has some drawbacks. It is useful because it provides convincing insight on the channels through which the policy change operates. It has drawbacks because the monopoly assumption is strong and the magnitudes it produces are better be discounted. We think that this cost is bearable since understanding the mechanism that the policy change diffuses into the economy is superior to trying to compute a single number perfectly foreseeing the policy effect, which we believe is an overly ambitious task given the data at hand.

In discussing the policy effects that our model predicts, we focus on one key parameter that naturally arises from our analysis: the π-elasticity of demand for checks, ε_π. In other words, we derive an explicit formula displaying the percentage change in the quantity of checks resulting from a percentage change in π. It is what we exactly need. We work out two versions of our model. First one, the *basic model*, assumes for simplicity that the demand for checks is of the constant elasticity form. This setup is simple but very useful in understanding how the model operates. It is less realistic because the effect of a policy is best detected on the margin and the policy response may change depending on how many people there are on the margin. In the second version, the *extended model*, we assume a simple preference heterogeneity for checks that would generate a distribution of individuals along the demand curve.

One merit of starting with a constant elasticity formulation is that it allows us test the following assertion: the demand for checks is inelastic. Checks have no close alternatives in the Turkish economy and it sounds correct to assume an inelastic demand curve. But, obviously, it is a loose statement. It may be the case that the margin that the monopolist operates is subject to a fairly elastic response. To study the effect of an increase in π, one needs to investigate what happens on the margin. In this study, we informally test the claim that the demand for checks should be inelastic. In fact, we reject the inelasticity hypothesis by establishing that the margin at which the monopolist operates is subject to an elastic policy response (see Section 4).

We show that the effect of an increase in π on the supply of checks depends on three main factors: the elasticity of demand for checks, the curvature of bad checks as a function of the total supply of checks, and how heterogeneous the willingness to pay is along the demand curve. We calibrate both versions using the available data and show that the π-elasticity of demand for checks, ε_π, is equal to -0.88 for the basic model and -1.70, on the margin, for the extended model. The original idea behind such a policy is to support the real economy by increasing the credibility of checks. The credibility would indeed increase but, unfortunately, the prospects for the real economy will not be as good as expected. We argue that drawee banks will tend to limit the burden that falls on themselves by restricting the supply of checks. This would hit the check-dependent sectors, especially the small enterprises who are less competitive in accessing liquidity.

This paper is structured as follows. Section 2 describes the basic theoretical framework. The main features of the model are discussed by means of a standard constant elasticity example. In Section 3, we extend the basic model by relaxing the constant elasticity assumption and incorporating heterogeneous preferences. Section 4 provides the data description, calibration and the main results. Section 5 concludes.

2 The Economic Environment

2.1 Basic Model

We assume perfect certainty and no informational asymmetries. The monopolist bank solves the problem

$$\max_{Q\geq 0}\Big[p(Q)Q - \pi\gamma b(Q)\Big] \tag{2.1}$$

by choosing the quantity of checks, Q, that he desires to sell, where $p(Q)$ is the inverse demand function (the implicit price of a check), $\pi > 0$ is the lump-sum monetary cost that the bank has to incur per bad check, $b(Q)$ is the number of bad checks as a function of the scale, Q, and $0 < \gamma < 1$ is a parameter representing the fraction of bad checks that the drawee banks pay

π. We assume throughout that $p(\cdot)$ and $b(\cdot)$ are continuous, twice differentiable for all $Q \geq 0$ and that $b'(\cdot) > 0$. The optimal quantity, Q_m, that the monopolist sells has to satisfy the first order condition

$$p'(Q_m)Q_m + p(Q_m) \leq \pi\gamma b'(Q_m), \tag{2.2}$$

with equality if $Q_m > 0$. The left hand side is the marginal revenue and the right hand side is the marginal cost. We assume $p(0) > b'(0)$, which implies that $Q_m > 0$ and, therefore, the first order condition holds with equality. The second order condition is

$$p''(Q_m)Q_m + 2p'(Q_m) < \pi\gamma b''(Q_m), \tag{2.3}$$

where $f'(x)$ and $f''(x)$ mean $\partial f(x)/\partial x$ and $\partial^2 f(x)/\partial x^2$, respectively. Dividing both sides of Equation (2.2) by $p(Q_m)$ and completing to elasticities, we obtain

$$\frac{1}{\varepsilon(Q_m)} + 1 = \frac{\pi\gamma b'(Q_m)}{p(Q_m)}, \tag{2.4}$$

where $\varepsilon(Q_m) < -1$ is the elasticity of demand for checks as a function of the monopoly output. Rearranging Equation (2.4) results in the usual monopoly mark-up formula

$$p(Q_m) = \frac{\pi\gamma b'(Q_m)}{1/\varepsilon(Q_m) + 1} = \frac{MC(Q_m)}{1/\varepsilon(Q_m) + 1}, \tag{2.5}$$

where $MC(Q_m) = \pi\gamma b'(Q_m)$ is the marginal cost of a check and $(1/\varepsilon(Q_m)+1)$ characterizes the wedge between the price and the marginal cost. The policy experiment we wish to perform is an exogenous increase in π which would induce the monopolist to react and adjust the quantity of checks he supplies. This is exactly what we intend to analyze: how an increase in π would lead to a change in Q_m. To see this concretely, we totally differentiate (2.5) as follows:

$$p'(Q_m)dQ_m = \frac{\pi\gamma b''(Q_m)dQ_m + \gamma b'(Q_m)d\pi}{1/\varepsilon(Q_m) + 1} - \frac{\pi\gamma b'(Q_m)\varepsilon'(Q_m)(1/\varepsilon(Q_m))^2 dQ_m}{(1/\varepsilon(Q_m) + 1)^2}. \tag{2.6}$$

After a few algebraic manipulations, it is possible to end up with a—rather obscure—formula for $dQ_m/d\pi$. The interpretation is the following. A change in the equilibrium quantity as a response to a change in π comes from three distinct sources: (1) the change in marginal cost, (2) the change in price, and (3) the change in the elasticity of demand. One and two is standard, but the effect of the third is nonexistent in a perfectly competitive environment. How the elasticity of demand changes in response to a shift in demand is not an easy concept to study. It can go either way. Although Equation (2.6) characterizes the object of interest, it is fairly intractable given the current general setting. Next we restrict ourselves to a familiar special case: the constant elasticity of demand. The constant elasticity assumption implies $\varepsilon'(Q) = 0$, which suggests a substantial simplification over Equation (2.6). It is useful to note at this stage that we take a partial equilibrium stance in this paper and abstract from general equilibrium effects. In section 3, we relax the constant elasticity assumption and work out a setup which allows for preference heterogeneity and an endogenous elasticity of demand.

2.2 A Constant Elasticity Example

For the ease of exposition, we assume that the demand for checks is of the following constant elasticity form:

$$p(Q) = \left(\frac{Q}{A}\right)^{1/\varepsilon}, \tag{2.7}$$

where $A > 0$ is a deterministic demand shifter and $\varepsilon < -1$ is the constant elasticity of demand. We restrict ε being less than -1 to ensure that the monopolist operates, i.e., $MR \geq MC$. With this simplifying assumption, Equation (2.5) is now written as

$$p(Q_m) = \frac{\pi\gamma b'(Q_m)}{1/\varepsilon + 1}, \tag{2.8}$$

which is useful since we have removed the effect of the scale on the elasticity of demand. Notice that, under the constant elasticity assumption, the second-order condition previously derived in Equation (2.3) can be rewritten as

$$\frac{p'(Q_m)}{p(Q_m)} < \frac{b''(Q_m)}{b'(Q_m)}. \tag{2.9}$$

Differentiating Equation (2.8) with respect to Q_m and π, holding ε and γ constant, we obtain

$$p'(Q_m)dQ_m = \frac{\pi\gamma b''(Q_m)}{1/\varepsilon + 1}dQ_m + \frac{\gamma b'(Q_m)}{1/\varepsilon + 1}d\pi. \tag{2.10}$$

Equation (2.10) characterizes what economists call the "pass-through" and is very useful. It gives us a theory of how the equilibrium price and quantity change in response to a change in π.[4] Manipulating (2.10) algebraically, it is possible to end up with a tractable formula for the parameter of central interest: the π-elasticity of demand, i.e., the percentage change in Q_m as a response to a percentage change in π. In other words, this setup enables us to reach a direct parameter reflecting the effect of a change in banks' obligatory payments on the equilibrium quantity of checks. This claim is the subject of the following proposition.

Proposition 1. *If the demand is of the constant elasticity form, $p(Q) = (Q/A)^{1/\varepsilon}$, and if $b(Q) = \alpha Q^{\beta}$, then*

a. it must be the case that $\beta > 1/\varepsilon + 1$;

b. the π-elasticity of demand, ε_π, is always negative and $\varepsilon_\pi = (\varepsilon/[1 - (\beta - 1)\varepsilon])$; and

c. ε_π is bounded from above by $-1/(\beta - 1)$.

Proof: Rearranging Equation (2.10), we get

$$\frac{dQ_m}{d\pi} = \frac{\frac{\gamma b'(Q_m)}{1/\varepsilon+1}}{p'(Q_m) - \frac{\pi\gamma b''(Q_m)}{1/\varepsilon+1}} \tag{2.11}$$

which can be simplified as

$$\frac{dQ_m}{d\pi} = \frac{1}{\pi\left(\frac{p'(Q_m)}{p(Q_m)} - \frac{b''(Q_m)}{b'(Q_m)}\right)} \tag{2.12}$$

[4] One important implication of the constant elasticity assumption is that pass-through is always more than one-for-one. In other words, one unit increase in the marginal cost affects the monopoly price (strictly) more than one unit. The reason for this result is the obvious fact that marginal revenue is always flatter than the demand curve for the constant elasticity case. In contrast, when the demand curve that the monopolist face is linear, the pass-through is always less than one-for-one. In fact, the pass-through will be a half since the slope of the marginal revenue curve is half the slope of the demand curve. If the demand curve is neither linear nor of the constant elasticity form, then pass-through can go either way and generally is not quite tractable. See Weyl and Fabinger (2008) for a comprehensive discussion of pass-through.

by using the mark-up rule. Notice that the expression in brackets in the denominator is identical to the second order condition. Therefore, we infer that $dQ_m/d\pi$ should always be negative. The assumption of constant elasticity of demand implies that

$$\frac{p'(Q_m)}{p(Q_m)} = \frac{1}{\varepsilon Q_m} \tag{2.13}$$

Substituting (2.13) into (2.12) yields,

$$\frac{dQ_m}{d\pi} = \frac{1}{\frac{\pi}{Q_m}\left(\frac{1}{\varepsilon} - \frac{b''(Q_m)Q_m}{b'(Q_m)}\right)}. \tag{2.14}$$

By setting $b(Q) = \alpha Q^{\beta}$, it is easy to see that

$$\frac{b''(Q_m)Q_m}{b'(Q_m)} = \beta - 1. \tag{2.15}$$

Using the second order condition, we verify that $\beta > 1/\varepsilon + 1$. After trivial algebra, Equation (2.14) simplifies to

$$\frac{dQ_m}{d\pi}\frac{\pi}{Q_m} = \varepsilon_\pi = \frac{\varepsilon}{1-(\beta-1)\varepsilon}. \tag{2.16}$$

Then we take the limit as ε goes to $-\infty$ and obtain

$$\lim_{\varepsilon \to -\infty} \varepsilon_\pi = -1/(\beta - 1)$$

as required. ■

Next section discusses the implications of this model and describes the details of the main mechanism.

2.3 Discussion

To understand what Proposition 1 communicates, we rewrite (2.8) using the assumed functional forms for $p(Q)$ and $b(Q)$. We solve for Q_m and get

$$Q_m = \left(\frac{\left(\frac{1}{A}\right)^{1/\varepsilon} \left(\frac{1}{\varepsilon} + 1\right)}{\pi\gamma\alpha\beta} \right)^{\frac{1}{\beta-(1/\varepsilon+1)}}. \tag{2.17}$$

Equation (2.17) provides an analytical solution to the equilibrium quantity of checks that the monopolist decides to sell given the demand function and the cost structure. This tells us that, in the determination of the supply of checks, there is an interplay between the policy parameter, π, the elasticity of demand, ε, and the curvature parameter of the cost function, β, i.e., how fast the share of bad checks rise in the total supply of checks as the output increase. To simplify the analysis further, we set $\alpha = 1$ and $A = 1$. We also set $\gamma = 1$ to see the workings of the model clearly. Hence, Equation (2.17) is now written as

$$Q_m = \left(\frac{1/\varepsilon + 1}{\pi\beta} \right)^{\frac{1}{\beta-(1/\varepsilon+1)}}. \tag{2.18}$$

As the elasticity of demand, ε, goes up, Q_m increases nonlinearly. Proposition 1 states that the effect of an increase in π on Q_m "in terms of percentages" is higher the higher the elasticity of demand (for a given β satisfying the second order condition). The intuition is simple. In an environment where the demand for checks is fairly elastic, we can argue that the composition of the demand-side is highly heterogeneous. In other words, for a significant fraction of customers, checks are easily substitutable. Hence, when banks restrict the supply of checks and, as a result, the price goes up, a lot of people substitute away from checks. But this substitution weakens with β and, eventually, the effect of ε on ε_π becomes almost irrelevant when β is extremely high. Figure (2.1) demonstrates the interplay between β, ε and ε_π as a function of ε.

The effect of β on ε_π is more subtle and more relevant for our context. Equation (2.18) states that Q_m goes down nonlinearly with β. In other words, when the perceived fraction of bad checks increases faster with scale, the monopolist restricts output for the purpose of decreasing his exposure to the risky economic environment. Hence, a higher β is associated with a lower

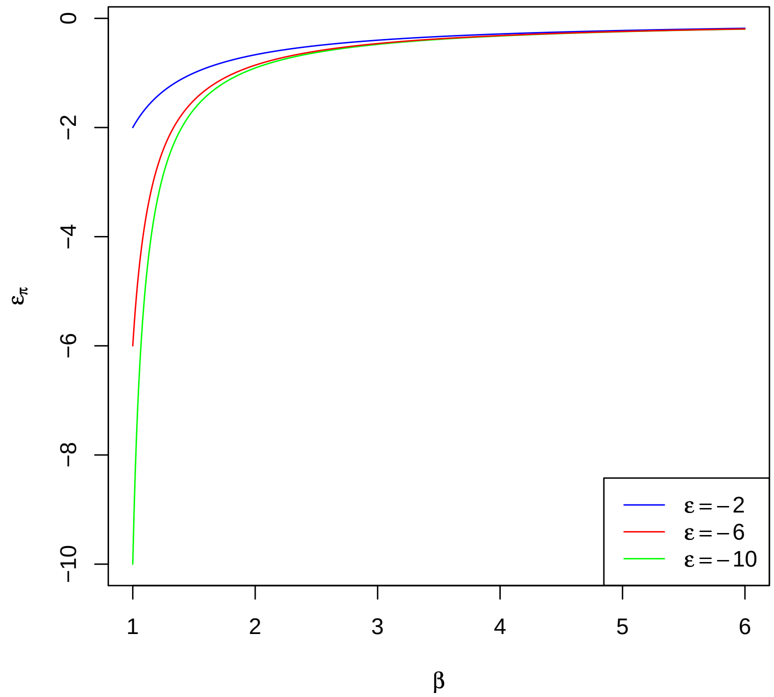

Figure 2.1: The interplay between β, ε and ε_π as a function of ε.

ε_π. The monopolist already supplies small quantities when β is high—when the cost function is convex—and will be less sensitive to changes in π because even small quantity restrictions will cause a more than enough decline in the cost. When the cost function is concave, i.e., $\beta \in (0, 1)$, the supply of checks become more responsive to changes in π since a large enough decline in cost requires a relatively larger cut in the supply of checks. Figure (2.2) displays the interplay between β, ε and ε_π as a function of β. Intuitively, the effect of β is larger the higher the elasticity of demand.

Two key features of this discussion should perhaps be reemphasized. First, the effect of a governmental decision to increase π would induce the monopolist to further restrict the supply of checks. Second, the extent of the monopoly distortion depends on (i) how elastic the demand for checks is, and (ii) how fast the fraction of bad checks increase with the scale. Obviously, the knowledge of ε and β would give a better sense when making policy decisions about π. Section 4 analyzes the available data on checks and attempts to provide a policy perspective.

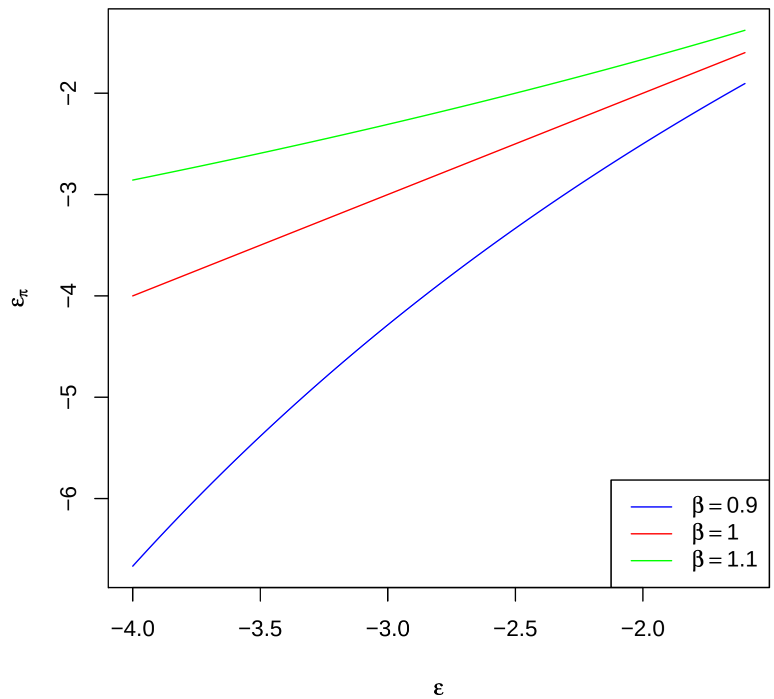

Figure 2.2: The interplay between β, ε and ε_π as a function of β.

It should be pointed out that the constant elasticity assumption homogeneizes the effect of an increase in π along the demand curve. In order to account for the fact that demand should be more inelastic at lower quantity levels, we have to deviate from the constant elasticity assumption. Maybe it is true that a sensible analysis of the market for checks in Turkey has to recognize that the demand for checks is fairly inelastic. This statement is judgmental, but justifiable since checks in Turkey have very attractive features (with no close substitutes) facilitating smooth running of cash management practices of firms. However, in analyzing the effect of a change in the market conditions on market outcomes, one needs to focus on the individuals on the margin. In other words, whether there are a lot of marginal individuals relative to infra-marginal individuals would be the key. For our context, this is of great relevance because it is important to know the density of individuals in the internal and external margins to detect the effects of an increase in π on Q with greater accuracy. Next we present an alternative formulation of demand, which is tractable and flexible enough to accommodate this more general idea.

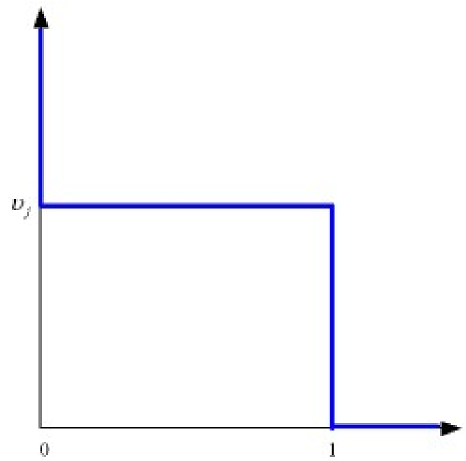

Figure 3.1: THE DEMAND CURVE FOR INDIVIDUAL j.

3 Heterogeneous Preferences

We model the demand side by distinguishing the external and internal margins. The characteristics of the market for checks allow us to make such a simplification. In other words, we can think of the market for checks in such a way that individuals are either able to get checks, $Q = 1$, or not, $Q = 0$. Figure (3.1) sketches the decision making rationale for each individual j, $j = 1, \ldots, N$, where N is the relevant population. It can be interpreted as the inidividual demand curve. If the monopoly price is above υ_j, the individual j will not buy checks, and will buy checks if it is below υ_j. One difference between this setup and the setup in the previous section is that Q is now the number of checkbook owners rather than the number of checks. We adjust for this difference when we calibrate our model in Section 4.

We assume a continuous and twice differentiable cdf, $F_\upsilon(\cdot)$, of υ_j in the relevant population, N, where υ denotes a nonnegative random variable representing individual tastes and p is a realization of υ. The shape of the market demand for checks depends on the population distribution of individual preferences. $1 - F_\upsilon(p) = \mathbb{P}[\upsilon_j \geq p]$ is the probability of individual j's valuation being strictly greater than or equal to some certain level, p. Thus, the number of individuals with values at least equal to p can be written as

$$Q(p) = N\big[1 - F_\upsilon(p)\big] \tag{3.1}$$

where N is the size of the relevant population. This is the market demand for checks. In this aggregate formulation, we account for the switching composition of who buys and who does not rather than individual substitution. Differentiating Equation (3.1) with respect to p yields

$$Q'(p) = -N f_{\upsilon}(p) \tag{3.2}$$

where $\partial F_{\upsilon}(p)/\partial p = f_{\upsilon}(\cdot)$ is the pdf of individual values. Completing to elasticities, we get

$$\varepsilon(p) = -p \frac{f_{\upsilon}(p)}{1 - F_{\upsilon}(p)} \tag{3.3}$$

which is a familiar expression. The term $\frac{f_{\upsilon}(p)}{1-F_{\upsilon}(p)}$ is a hazard rate. It is the hazard of being on the margin and it measures how many individuals there are on the margin relative to how many are currently buying checks. The demand will be very elastic when there are a lot of individuals on the margin relative to the number of infra-marginal individuals. Given p, if we have lots of people with very similar taste and if price tends to be close to that level, we get a very elastic response. As a result, the shape of the market demand curve for checks largely depends on the form of F_{υ}.

For concreteness, we assume that the distribution of tastes is exponential. In other words, we assume

$$F_{\upsilon}(p) = \mathbb{P}[\upsilon_j \leq p] = 1 - e^{-\lambda p}, \tag{3.4}$$

where $\lambda > 0$ is the rate parameter governing the spread of the exponential distribution. This assumption greatly simplifies our analysis since it produces a constant hazard rate which is a well-known property of the exponential distribution. More precisely, it produces

$$\frac{f_{\upsilon}(p)}{1 - F_{\upsilon}(p)} = \lambda.$$

This directly implies that $\varepsilon(p) = -p\lambda$. In other words, (i) the law of demand holds, (ii) the elasticity of demand is parameterized by, λ, the rate parameter of the exponential distribution, and (iii) the elasticity changes along the demand curve since it is a function of p. As λ increase, the tail of the distribution becomes thinner.

Why exponential distribution? Although the extended model relaxes the constant elasticity assumption since we question the relevance of the idea that the demand for checks has to be inelastic, we still have the prior belief that there are no alternatives to checks. This prior belief lets us think that the fraction of people with a higher willingness to pay is better be larger than the fraction of people with lower willingness to pay at the equilibrium. Exponential distribution fits into this idea and the degree of dispersion is governed by the parameter λ, which we compute in Section 4 using an iterative algorithm.

To characterize the properties of the equilibrium outcome in this version of our model, we rewrite the monopoly problem by letting the monopolist choose price instead of quantity in the following way:

$$\max_p \Big[pQ(p) - \pi\gamma b\big(Q(p)\big)\Big]. \tag{3.5}$$

This is equivalent to the formulation in (2.1). The first order condition then writes

$$Q(p_m) + p_m Q'(p_m) = \pi\gamma Q'(p_m) b'\big(Q(p_m)\big)$$

where p_m is the monopoly price. After trivial algebra, we get

$$p_m \left[1 + \frac{1}{\varepsilon(p_m)}\right] = \pi\gamma b'\big(Q(p_m)\big). \tag{3.6}$$

The second order condition is

$$p_m Q''(p_m) + 2Q'(p_m) < \pi\gamma \left[Q''(p_m) b'\big(Q(p_m)\big) + \big(Q'(p_m)\big)^2 b''\big(Q(p_m)\big)\right]. \tag{3.7}$$

Plugging Equations (3.1) and (3.2) into (3.6) and (3.7), and using the assumption of exponentially distributed tastes, we obtain

$$p_m - \frac{1}{\lambda} = \pi\gamma\alpha\beta N^{\beta-1}\left(e^{\lambda p_m(1-\beta)}\right). \tag{3.8}$$

The monopoly price, p_m, is determined as a fixed point in Equation (3.8). The optimal quantity is determined using the demand relationship

$$Q(p_m) = Ne^{-\lambda p_m}. \tag{3.9}$$

Proposition 2. *The monopoly price, p_m, is a decreasing function of λ if $\beta > 1$.*

Proof: We differentiate both sides of Equation (3.8) by p_m and λ which yields

$$dp_m + \frac{1}{\lambda^2}d\lambda = p_m(1-\beta)\left(p_m - \frac{1}{\lambda}\right)d\lambda + \lambda(1-\beta)\left(p_m - \frac{1}{\lambda}\right)dp_m.$$

Regrouping the terms and using the elasticity formula, $\varepsilon(p_m) = -\lambda p_m$, we obtain

$$\frac{dp_m}{d\lambda} = \frac{\frac{1}{\lambda^2}\left[\varepsilon(p_m)(1-\beta)(\varepsilon(p_m)+1)-1\right]}{1+(1-\beta)(\varepsilon(p_m)+1)}$$

The denominator is positive and the numerator is negative since $\varepsilon(p_m) < -1$ and $\beta > 1$. Hence, it follows that $dp_m/d\lambda < 0$ as required. ■

In words, as tastes become more dispersed, the monopolist charges a lower price if the cost function is convex, which we verify in Section 4. The intuition is the following: when there are more people on the margin relative to the poeple who currently have checks, the monopolist charges a lower price to induce more people to come in. A higher λ means that the people with high willingness to pay are represented by a higher fraction in the population. The upper tail becomes less elastic and the lower tail becomes more elastic. Then the most important question is: where does the monopolist operate? This depends on the magnitude of λ. We answer this question in Section 4 where we calibrate our model. The answer to this question is of extreme importance for our analysis since it determines how widespread would the effect of an increase in π be.

Although the setup in the extended model is fairly different from that in the basic model, the mechanisms they work through are quite similar. Proposition 3 displays this similarity.

Proposition 3. *If the demand for checks is of the binary structure and if preferences are exponentially distributed, then*

a. our policy parameter ϵ_π becomes a function of the scale and

$$\varepsilon_\pi(p_m) = \frac{\varepsilon(p_m)+1}{1-(\beta-1)(\varepsilon(p_m)+1)};\ \textit{and} \tag{3.10}$$

b. it must be the case that $(\varepsilon(p_m)+1)(\beta-1) < 1$.

PROOF: We totally differentiate Equation (3.9) and get

$$dQ_m = -\lambda N e^{-\lambda p_m} dp_m \ \ \Rightarrow \ \ dp_m = -\frac{1}{\lambda}\frac{dQ_m}{Q_m} \tag{3.11}$$

Differentiating Equation (3.8) with respect to p_m and π, we obtain

$$dp_m = \left(p_m - \frac{1}{\lambda}\right)\frac{1}{\pi}d\pi - \lambda(\beta-1)\left(p_m - \frac{1}{\lambda}\right)dp_m, \tag{3.12}$$

which implies, after completing to elasticities, that

$$\left(1-(\beta-1)\left(\varepsilon(p_m)+1\right)\right)dp_m = -\frac{1}{\lambda}\left(\varepsilon(p_m)+1\right)\frac{d\pi}{\pi} \tag{3.13}$$

We then plug the expression (3.11) in (3.13) to get the required result. This completes part a. For part b, we start with plugging the demand equation into the second order condition (3.7). Then the result is immediate. ■

In the basic model, only β and ε determine the policy parameter, ε_π. Proposition 3 states that an almost identical expression holds in the extended model. $\varepsilon_\pi(p_m)$ is determined by β and $\varepsilon(p_m)$. The difference is that $\varepsilon(p_m)$ and, therefore, $\varepsilon_\pi(p_m)$, are functions of p_m. As a result, as obviously seen from Equation (3.8), all parameters affect the policy outcome in the current version.

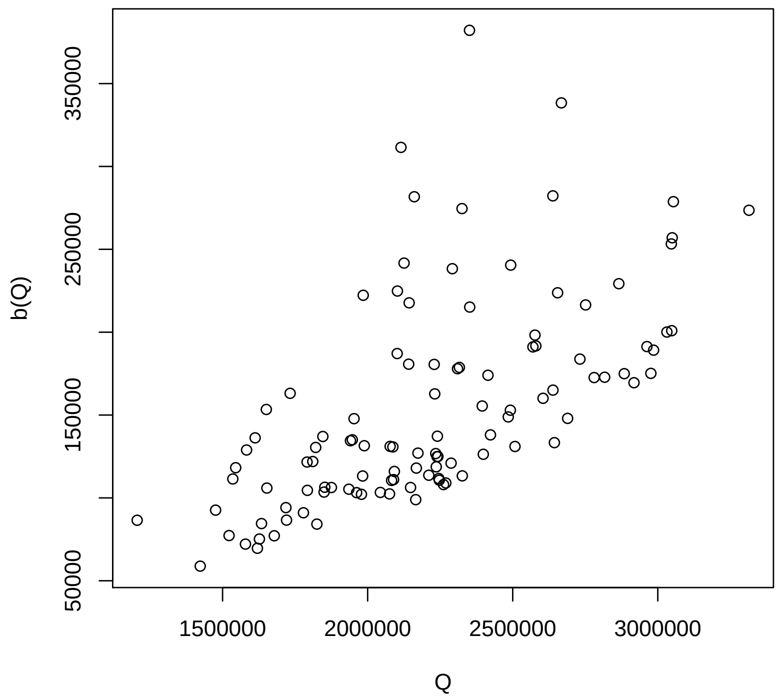

Figure 4.1: The number of bad checks versus the total quantity of checks.

In the next section, we use the available data to calibrate the two versions of the model. We compare the predictions of the constant elasticity and the binary demand models.

4 Data, Calibration, and Numerical Results

The available data on checks has been collected by the Central Bank of the Republic of Turkey and covers the period 2000-2009 on a monthly basis. We have access to data on the total number of checks issued, Q, and the number of bad checks, $b(Q)$, as well as the aggregate face values of these two variables. The data is aggregated across banks and individual effects are not detectable.

Figure (4.1) plots Q against $b(Q)$. Obviously, $b(Q)$ is *increasing* in Q. But whether it is linear, convex or concave in Q is not obvious. This relates to the magnitude of β. Proposition 1.a states that it must be the case that $\beta > 1/\varepsilon + 1$. The monopolist operates only if $\varepsilon < -1$,

Parameter	Estimate	St.Error
$\log(\alpha)$	-6.8	1.91
β	1.28	0.13

Table 2: RESULTS FROM REGRESSING THE LOG OF b ON THE LOG OF Q. The number of observations is 107. The data is monthly and covers the period 2000-2009. We ignore 9 data points which are reported to contain incomplete information. $R^2 = 0.46$, F-statistic = 94.7.

which implies that $\beta > 0$. This is consistent with what Figure (4.1) says. So the question is the following: what is the magnitude of β?

The customer screening procedures of drawee banks are not explicitly modeled in this paper. Nevertheless, it is not hard to imagine that $\beta > 1$. Since banks supply checks to the safest customers first, one would naturally think that the share of bad checks would rise in an increasing fashion as the bank spreads out checkbooks to new customers. In other words, the selection process of the drawee banks would govern the parameter β. A second factor could be the state of the economy. During recessions, one would expect to have a higher β than in booms.

In estimating β, a microeconomic setup focused on screening and filtering of customers by banks would be a natural starting point. However, such an approach will be seriously bounded by the lack of micro data. Given that we only have data on the total supply of checks and the total quantity of bad checks, the number of methods that one could use to estimate β is limited. To have a rough idea on the magnitude of β, we run the following naive regression:

$$\log(b_t) = \log(\alpha) + \beta \log(Q_t) + \eta_t$$

which is based on the presumed relationship $b(Q) = \alpha Q^{\beta}$. Table (2) summarizes the estimates of this simple least squares regression.

We estimated versions of this regression equation incorporating variables representing the macroeconomic performance of the economy. We tried GDP growth rate and the growth rate of industrial production along other variables. We found higher estimates for β ranging between 1.6 and 2.1 (with slightly lower significance levels). However, we are cautious about these

Parameter	Value	Matched to Fit
α	0.0011	Regression outcomes.
β	1.30	Regression outcomes.
A (basic model)	4.1×10^8	Average $Q = 2.2$ million.
ε (basic model)	-1.20	By hypothesis.
γ	0.24	Balance in the check accounts.
N	7.5 million $\times$ 25	Number of commercial bank accounts.
π	TRY 470	Current level of the policy tool.
λ (extended model)	0.27	Average $Q = 2.2$ million.

Table 3: CALIBRATION.

alternative estimates because of two reasons: (i) total number of checks and the macroeconomic state are possibly correlated and (ii) our model does not incoporate macroeconomics. Hence, using the original regression, we choose $\beta = 1.3$ and $\alpha = e^{-6.8} \approx 0.0011$.

Our goal, for the rest of this section, is to calibrate the model parameters A, γ, ε, π, λ, and N, and then compare the responses of Q_m in the basic model and in the extended model to an increase in π. Note that we calibrate ε only for the basic model. The elasticity of demand is endogenous in the extended model. The basic model shows us how the mechanism works, whereas the extended model is a closer approximation to reality. We then interpret the results and evaluate policy implications.

Table (3) summarizes the calibration. As we discuss earlier, considering the fact that the monopolist operates only if $\varepsilon < -1$, we set $\varepsilon = -1.2$ to test the judgmental hypothesis that the demand for checks is inelastic. We calibrate γ using the balance in the relevant account in the banks. We divide that number by π and find the total number of checks that the banks paid π. Then, we divide this number to the total number of bad checks to obtain $\gamma = 0.24$. To calibrate A, we first find average Q over the data horizon, and then use Equation (2.17) which yields $A = 4.1 \times 10^8$.

The task of calibrating λ is more subtle. We use the following guess-and-verify algorithm to jointly determine λ and p_m.

Algorithm 1. ***Calibrating $\boldsymbol{\lambda}$.***

1. *Calculate $\bar{Q}$, the average Q.*

2. *Set an initial level of λ and calculate p_m using Equation (3.8).*

3. *Calculate Q_m in Equation (3.9).*

4. *If $Q_m = \bar{Q}$, stop. If $Q_m > \bar{Q}$ ($Q_m < \bar{Q}$), decrease (increase) λ and compute a new p_m. Iterate over Step 3, until Q_m converges to $\bar{Q}$.*

Notice that in Step 4 we use the statement in Proposition 2 to determine the direction of convergence. Alternatively, one could use an appropriately formulated Riccati equation to compute an iterative solution to the limiting outcome. In calibrating λ, the most important point is the definition of Q. We have access to data on the number of checks in circulation and the number of bad checks. We do not have information on how many people have access to checks. Normally, when an agent is entitled to use checks, he can own a checkbook with (on average) 25 checks. But, there is no way we can filter the data to make such an adjustment. Instead, we reinterpret our model as a model of willingness to pay *per check* rather than the number of individuals. To determine the size of the relevant population, N, we need to account for both the internal margin and the external margin in the market for checks. We use the publically available BRSA (Banking Regulation and Supervision Agency) data on the number of commercial bank accounts. These are actual and potential checkbook owners. We set $N = (7.5 \text{ million}) \times 25$, which is the number of commercial bank accounts (as of the beginning of 2009) times the average number of checks per checkbook. We need to make this adjustment because the data we have is in terms of the number of checks. After running Algorithm 1, we find $\lambda = 0.27$.

Table (4) summarizes the main results. It shows that accounting for heterogeneity in preferences results in a substantially larger policy effect. Since the rate parameter, λ, is low, the dispersion of tastes is large, i.e., the preference distribution has a fat tail. This means that the mass of individuals with lower willingness to pay is large. This induces a higher price, since, by Proposition 2, the monopoly price is a decreasing function of λ.

We, therefore, (informally) reject the hypothesis that the demand for checks ought to be

Parameter	Predicted by the model
ε_π (basic model)	-0.88
ε_π (extended model)	-1.70
ε (hypothesized)	-1.20
ε (extended model)	-4.47
p_m (extended model)	TRY 16.53
Q_m (extended model)	Average $Q = 2.2$ million

Table 4: Model predictions.

inelastic. According to the extended model, the elasticity of demand for checks is -4.47 on the margin, which is way larger than the hypothesized elasticity, -1.2. As Propositions 1 and 3 state, the more elastic the demand for checks, the higher the policy response. The extended model predicts a 1.7 precent decrease in the total supply of checks as a response to one percent increase in π. These results imply that the margin that the monopolist operates is subject to a very elastic response. This is probably because the firms on the margin are mostly small- and medium-scale enterprises with low willingness to pay. Since λ is low, the hazard of being on the margin, in other words, the number of people on the margin relative to the number of agents with checkbooks, is low. But a low λ induces a high monopoly price which puts a further downward pressure on the demand for checks making the response elastic.

5 Concluding Remarks

This paper formally discusses the potential effects of a proposed policy action in Turkey: an increase in π, the amount that drawee banks are legally obliged to pay per bad check. In other words, the Turkish government considers supporting the real economy by increasing the credibility of checks. During economic downturns, particularly small-scale enterprises complain that they are having difficulties in getting full payment for their checks when they demand a cash out. One policy measure is to increase the amount that drawee banks are legally responsible to pay. However, our economic analysis of what could happen in response to such a policy measure establishes that drawee banks would cut the supply of checks which, in turn, would hit the real economy. The policy target is to ease the risk of liquidity shortages that the small firms are exposed to. On the contrary, our analysis predicts that an increase in π would first hit small-scale enterprises.

We argue that the magnitude of the effect of an increase in π on the total supply of checks depends on the elasticity of demand for checks, how fast the fraction of bad checks increase with the total quantity of checks and how heterogeneous are the tastes. We show that the claim that the demand for checks should be inelastic is, in fact, not true by establishing that the policy response on the margin is fairly elastic. Although the accuracy of our results are questionable since the quality of data we have access to is low, the workings of the mechanism we demonstrate are sensible. Understanding this mechanism will be of great importance especially when π is used a policy instrument. How the macroeconomic performance interacts with the market for checks is a relevant question and we leave answering that question for future research.

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