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Some Fresh Perspectives on Price-Support Policies

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ABSTRACT

Trade protection remains a prominent feature of the current world economy and likely has significant effects on industries and macroeconomies. In this paper a particular type of policy, price supports, is analyzed in a two-country, dynamic, general equilibrium model. This model brings new perspectives to the analysis in that it is monetary and has labor mobility within countries between the traded-goods and non-traded-goods sectors. It is found that:

- The introduction of price supports in an economy benefits only the agents currently working in the traded-goods sector.
- Cooperation among countries in setting policies results in a higher level of price supports than does noncooperation.
- Price-support policies can importantly affect the transmission of monetary policy effects, introducing permanent changes in real variables where there were none before and even reversing the signs of changes in some variables.

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Even as world economies enter a new era of globalization, trade protection remains a prominent feature of the economic landscape. For instance, the cost of trade protection in the European Union is estimated to be roughly 7 percent of its GDP—about $600 billion a year.[1] Trade-protection policies of that magnitude likely have significant sectoral impacts and also could have sizable effects on the macroeconomy.

In this paper, a particular type of trade-protection policy is analyzed in a model with some features that are more or less standard, as well as some features not commonly found in models of trade protection. The latter features bring some new perspectives to the analysis.

The policy analyzed is price supports for the traded good. In a sense, the government is assumed to purchase quantities of the domestically produced traded good and dump them into the ocean.

The policy analyzed here is a stylized version of one of many policies actually in use. Countries use, in addition, policies such as tariffs, import quotas, export subsidies, antidumping duties, and voluntary restrictions on foreign exports. However, this paper's analysis also has implications for those other policies. The crucial differences among the policies from this paper's perspective are their effects on government budgets and their spillover effects on the other countries.[2] In the concluding section, implications from the present analysis are drawn for the economic effects of those other policies.

The model used for the analysis is a straightforward adaptation of the Chin-Miller (1998) model. That model has some features that most economists would agree are useful in analyzing the effects of trade-protection policies:

- It is a two-country trade model with the economies of each country described explicitly from the bottom up.

- The effects of policies adopted in one country spill over to the other economy through both capital and goods markets.
- In each country, there are traded-goods and nontraded-goods sectors, so that relative prices and real exchange rates can be affected by trade-protection policies.
- Because the model is micro-based and dynamic, trade-protection policies can be related directly in both countries to the utilities of all agents at all times.
- The model has rational, forward-looking agents and some initial labor-market inertia, so its dynamics are nontrivial.

The Chin-Miller model also has features that provide some new perspectives to the analysis:

- After the initial period, new agents are free to choose in which of the economy's sectors to work based on which offers the higher expected utility. That feature has important implications for both the model's macroeconomic dynamics and the welfare dynamics of agents working in each sector.
- Because of the explicit modeling of agents' and policymakers' decision problems, trade-protection policies can be analyzed as a game. Thus, differences can be determined based on whether or not the governments of the two countries choose to cooperate on their trade-protection policies.
- The Chin-Miller model is monetary, and it suggests an interaction between a country's monetary and trade-protection policies, as each policy differentially impacts absolute prices and relative prices.

While the model is complicated, its implications are intuitive and seem applicable to wide classes of models. Some of the main findings from the analysis together with brief explanations follow:

1. The introduction of price supports in an economy raises the welfare only of agents currently working in its traded-goods sector. In the future, the expected utilities of agents working in either sector must be the same since new entrants are free to choose in which sector to work. And since the introduction of price-support policies introduces an inefficiency into the economy, the cost of that inefficiency in the future is borne equally by all agents in terms of lower utilities.
2. Cooperation among countries in setting policies results in a higher level of price supports than does noncooperation. When a government buys traded goods and dumps them in the ocean, the world's supply of traded goods shrinks, benefiting the agents in other economies' traded-goods sector. Because the other economies do not bear the cost of the goods that are dumped, they actually benefit more from a country's price-support policy than does the country itself. This positive spillover effect is internalized under the cooperative policy regime.
3. The existence of price-support policies can importantly affect the transmission of monetary policy effects, introducing permanent changes in real variables, such as the real exchange rate, where there were none before, and reversing the signs of changes in other variables, such as relative prices. Since price-support policies permanently alter the supplies of goods available, they have permanent real effects. Because a change in one country's monetary policy implies a different desired level of price supports, it will also have permanent real effects. Moreover, since a change in one coun-

try's monetary policy makes the economies asymmetric, the desired level of price supports will be different across countries, resulting in a permanent change in the real exchange rate. In the present model, a tighter monetary policy in one country lowers both its price level and its relative price of traded goods to nontraded goods, while a higher level of price supports raises each. Thus, it is possible that the existence of price-support policies causes a response to a monetary policy's price level effects that actually reverses the monetary policy's relative price effects.

In Section I, the Chin-Miller model is informally described. The model's description is limited to provide readers of this paper with the background to understand the results. (A formal description of the Chin-Miller model is contained in the original publication.) In Section II, the design and results of the noncooperative and cooperative price-support experiments are described. The section begins with definitions of policy moves and policy games. Next, the effects of a policy move are analyzed; that is, what follows when one country's government raises its consumption of the traded good. Outcomes of noncooperative and cooperative price-support policy games are then discussed, with reference to the analysis of policy moves. In Section III, the interaction between price-support policies and monetary policies is examined. First, the section summarizes some selected results from Chin-Miller on the effects of a monetary policy move in one country when price-support policies are not free to respond. It then shows how some of those effects can be changed or even reversed when the countries are playing a noncooperative price-support policy game in which moves can respond to monetary policy changes. Thus, it is established that which policy makes the last move importantly affects the results. Finally, in the conclusion, implications of this analysis are drawn for other types of trade-protection policies.

I. Model

For this study's analysis, I straightforwardly adapt the Chin-Miller open-economy model. I briefly describe the Chin-Miller model and the few changes made to it for this study.

The Chin-Miller model is composed of two economies, each with constant populations of two-period lived agents. Each economy has a public and a private sector. The public sector has a budget authority that taxes, spends on both traded and nontraded goods, and issues debt to finance deficits. It also has a monetary authority that engages in open-market operations and imposes a reserve requirement. The reserve requirement specifies that a percentage of domestic savings must be held in the domestic currency; it can be thought of as applying to deposits when all borrowing and lending is intermediated by banks. Agents in the private sector work in either the traded-goods or the nontraded-goods industries. If they work in the traded-goods industry, they are referred to as farmers. Farmers produce more in their second period of life than in their first and thus tend to be borrowers. If agents work in the nontraded-goods industry, they are referred to as service providers. Service providers produce more in their first period of life than in their second and thus tend to be lenders. When agents first come on the scene, they choose in which industry to work over their lifetime, based on a comparison of the utilities each choice generates. All debt, public and private, is perfectly substitutable and is traded in a world capital market. Money is held solely in the country that issues it and solely to satisfy the reserve requirement.

The effects of changes in monetary and budget policies depend in a model on how those policies are defined. And those definitions often vary across models.[3] Here, monetary policy actions are taken to be open-market operations: exchanges between interest-bearing and noninterest-bearing government debt. The policy is parameterized as the ratio of the market value of own-country government bonds to the stock of own-country base money, or β and β^* for the home and foreign countries, respectively. Budget policy in a country is defined by its government's real consumption of the traded and nontraded good, g^f and g^s, respectively, and by its level of lump-sum taxes, τ (all policy parameters are defined similarly in the foreign country with asterisks as superscripts). It is assumed that governments consume more than they tax, so the budget authorities run permanent net-of-interest deficits, which they finance with interest-bearing debt. (This assumption implies that in steady states with positive real interest rates inflation must be positive in each country to finance government deficits.)

Those definitions of policy have some nice properties. Within an economy, period-by-period monetary and budget policies can be set independently. (However, coordination over time is required because of unpleasant monetarist arithmetic.) Budget policy determines the total amount of government debt; monetary policy determines its composition between bonds and base money. Moreover, constant policies, as parameterized here, correspond to steady states.

In the Chin-Miller model, the economies are assumed to be initially in steady states. Any policy changes, or other parameter changes, are assumed to occur right after the young have made their work decision. The changes are assumed to be once-and-for-all deviations from the initial steady-state values. All future generations are free to make all of their decisions, including the industry in which to work, in response to the changed policy or other economic parameter.

The dynamic effects of policy changes in the Chin-Miller model derive from six key features of that model:[4]

1. There are no bequests, so Ricardian equivalence does not hold. Thus, an increase in the world's supply of debt increases the world's real interest rate.
2. Some agents hold nominal outside wealth in the initial period. A policy change that affects the initial price level then affects real wealth and, thereby, other real variables.

3. The presence of nontraded goods allows international shifts in wealth to affect relative prices and real exchange rates.
4. Strict monetarism holds in the sense that a country's price level is in fixed proportion to its money stock at all dates. (Actually, this relationship holds precisely only when relative prices are unchanging. Otherwise, the relationship that holds at all dates is that the price of the traded good is in fixed proportion to the money stock.)
5. Unpleasant monetarist arithmetic prevails in a country in the sense that an open-market sale at date *t* raises the rate of inflation at all future dates. That outcome occurs because the sale implies more government bonds outstanding at a higher real interest rate, so more seignorage is required to meet the increased interest payments on government bonds.
6. The reserve requirement drives a wedge between the world's real interest rate that borrowers pay and the lower real rate of return that savers receive.

A few simple changes were made to the Chin-Miller model to enable the analysis in this paper. In the Chin-Miller model, the initial old generation is considered in total: no attempt is made to determine the division between farmers and service providers, and no attempt is made to determine the private debt of farmers that is held by the service providers. However, the initial old service providers must hold a determinate amount of outside government debt—money and maturing bonds—for the initial dynamic equilibrium to be a steady state.

As described in the introduction, the adoption of a price-support policy can benefit only the agents currently working in the farm sector. To judge the desirability of a price-support policy, it is then necessary to specify the number of initial old farmers and their private debt to the initial old service providers. As one change to Chin-Miller, those values are equated to the steady-state values for corresponding old agents in the initial equilibrium. The initial wealth assumptions ensure that the consumption allocations of the initial old farmers and service providers are identical to the second-period allocations of the initial young and all future generations in the initial steady state. Thus, the economies can be thought to have been in the initial steady state back through all time.

Although the Chin-Miller model alternately assumes fixed and floating exchange rate systems, only a floating exchange rate system is assumed here. Moreover, for the current analysis, another change is made to the Chin-Miller setup. When once-and-for-all changes in monetary policy are considered, budget policy is allowed to respond, or to not respond (as in Chin-Miller). A responsive budget policy is taken to be a price-support policy for the traded good. A price-support policy is specified by an objective, an instrument, and rules of the game played by the two governments. The objective is to maximize a weighted sum of generational utilities for farmers and service providers taken separately. Generational utilities are defined for agents in each sector as the discounted sum of the per-capita utility for the current old, current young, and all future generations. The instrument is government consumption of the traded good. Price-support policies are derived both when the two governments act noncooperatively (Nash solution) and when they act cooperatively (cooperative solution).

II. Price-Support Policy Games

An outcome of a policy game consists of the policy moves made by each country in equilibrium and the values of economic variables that result from those moves. Equilibrium moves are those that maximize each country's objective function subject to the constraints that it faces. Thus, to understand the nature of equilibrium moves, one must first understand the effects of an arbitrary policy move: a change in one government's consumption of the traded good; that is, Δg^f or Δg^{f*}.

Initially, the two economies are assumed to be in a steady state with no price supports; that is, with $g^f = g^{f*} = 0$.[5] All policy moves then are unanticipated changes from the initial steady state. Thus, for example, when linearity of the model is being checked with respect to a change in g^f at points $\langle g^f, g^{f*} \rangle = \langle a,a \rangle$ and $\langle b,b \rangle$, the differences being compared in the model's outcomes $M(\Delta g^f, \Delta g^{f*})$ are $M(a+dg^f,a) - M(a,a)$ and $M(b+dg^f,b) - M(b,b)$, where a and b are changes from zero and dg^f is a small additional change of a given size.

In addition to a specification of policy moves, formal descriptions of policy games require a specification of objectives. The objective of each country's price-support policy is to maximize as of date $t = 1$ the weighted sum of generational utilities from generation $t = 0$ onward. Define the weighted sum of generational utilities for farmers in the home country to be

$$W(1)^f \equiv \sum_{t=0}^{\infty} \delta_s^t U_t^f ,$$

where δ_s is a social discount factor, set at 0.70 in the numerical exercises that follow, and U_t^f is the utility of an agent of generation t working in the farm sector.

The utility of an initial old farmer U_0^f is taken to be the utility associated with consumption of services and food in the second period of life at date $t = 1$, specifically $\theta \ln c_0^s(1) + (1-\theta)\ln c_0^f(1)$. Now, define analogously the weighted sums of generational utilities for service providers in the home country $W(1)^s$, farmers in the foreign country $W^*(1)^f$, and service providers in the foreign country $W^*(1)^s$. The objectives, then, are to maximize

$W(1) \equiv \alpha W(1)^f + (1-\alpha)W(1)^s$ in the home country, and

$W^*(1) \equiv \alpha W^*(1)^f + (1-\alpha)W^*(1)^s$ in the foreign country.

For the numerical exercises that follow, α, the weighting factor, is set at 0.62.

The Nash and cooperative policy games can be described in terms of the objective functions and policy moves. For the Nash game, the home country maximizes $W(1)$ with respect to Δg^f for a given value of Δg^{f*}, and the foreign country maximizes $W^*(1)$ with respect to Δg^{f*} for a given value of Δg^f. A Nash equilibrium is a pair $<\Delta\hat{g}^f,\Delta\hat{g}^{f*}>$ such that $\Delta\hat{g}^f$ maximizes $W(1)$ given $\Delta\hat{g}^{f*}$ and $\Delta\hat{g}^{f*}$ maximizes $W^*(1)$ given $\Delta\hat{g}^f$. For the cooperative game the two countries jointly maximize $W(1) + W^*(1)$ with respect to $\Delta g^f = \Delta g^{f*}$, and the solution is denoted $\Delta\hat{\hat{g}}^f = \Delta\hat{\hat{g}}^{f*}$.

We begin the analysis by examining the macroeconomic and welfare effects of a policy move $\Delta g^f = .04055$; that is, $M(.04055,0) - M(0,0)$.[6] We next show that the model's macroeconomic outcomes are approximately linear with respect to initial support level, as described above, and with respect to size of dg^f. In particular, we compare the macroeconomic outcomes of $M(\Delta\hat{g}^f{+}2dg^f,\Delta\hat{g}^{f*}{+}2dg^f) - M(\Delta\hat{g}^f,\Delta\hat{g}^{f*})$ and $2[M(\Delta\hat{g}^f{+}dg^f,\Delta\hat{g}^{f*}{+}dg^f) - M(\Delta\hat{g}^f,\Delta\hat{g}^{f*})]$ where $\Delta\hat{g}^f = \Delta\hat{g}^{f*}$ is the Nash equilibrium value of government consumption in each country, dg^f is as before .04055, and $\Delta\hat{g}^f + 2dg^f = \Delta\hat{g}^{f*} + 2dg^f$ is the cooperative equilibrium value of government consumption in each country. Finally, we show that because agent preferences are characterized by modestly decreasing marginal utility, the approximate linearity of macroeconomic outcomes is not as pronounced for welfare. The results relating to policy moves are used subsequently to explain why Nash and cooperative equilibria exist and why the equilibrium level of price supports in the cooperative game exceeds that in the noncooperative game.

A. The Effects of a Policy Move: $\Delta g^f > 0$.

We examine the dynamic macroeconomic and welfare effects of a change in one country's price-support level by comparing $M(\Delta g^f,\Delta g^{f*})$ for $\Delta g^f = \Delta g^{f*} = 0$ and for $\Delta g^f = .04055$ and $\Delta g^{f*} = 0$. Figures 1 through 10 indicate how macroeconomic outcomes are affected by a price-support policy move.[7] Initial steady-state values are represented by the zero lines, and differences from the steady state when $\Delta g^f > 0$ are represented by the diamonds. At date $t = 0$, the outcomes are for the initial steady state. At date $t = 1$, the outcomes reflect the effects of increased government consumption of the traded good when agents' choice of industry in which to work is the same as in the initial steady state. The outcomes from date $t = 2$ and beyond are generated when agents coming on the scene have full labor mobility.

Since the macroeconomic outcomes at date $t = 1$ and at future dates can be very different, they are explained in order. At date $t = 1$ all production is fixed, because labor is the only flexible input and its allocation is fixed. An increase in the home country government's spending for the traded good directly increases its budget deficit. Since the model is non-Ricardian, the increase in borrowing raises the world's real interest rate ρ. The increase in consumption of the traded good in the home country raises the price of its traded good relative to the price of its nontraded good, which is reflected in the model by a fall in $Q \equiv p^s/p^f$, where p^s = price of "services" (nontraded good) and p^f = price of "food" (traded good). At date $t = 1$, the increase in world demand for food also results in a fall in Q^*, the relative price of services to food in the foreign country.

The increase in the home country government's consumption of food at date $t = 1$ raises both the price level[8] P and the rate of inflation π. An increase in the amount of government debt to finance an increase in government spending coupled with a constant ratio of money to bonds raises the stock of money and, hence, the price level. A higher real interest rate and a higher stock of debt result in a higher interest expense on the debt and, hence, the need for higher seignorage in the form of inflation beginning at date $t = 1$, where the inflation rate at date t is measured by $\pi(t) = [P(t+1) - P(t)]/P(t)$, and P is defined as $p^{s\theta}p^{f(1-\theta)}$. Although the price effects are qualitatively the same in the foreign country, the magnitudes are much smaller. That is because its budget deficit is increased only from the higher interest on its debt coming from a higher world real interest rate. It does not also have to finance a higher level of government consumption.

At date $t = 1$ labor is immobile, so there is no change from the steady state in labor allocations in either country. Since the price of food rises more in the home country than in the foreign country, the nominal exchange rate e, defined as $e \equiv p^{f*}/p^{f}$, falls. Similarly, since the relative price of food to services rises more in the home country than in the foreign country, the real exchange rate $\bar{e}$ also falls, where $\bar{e}$ is defined by $\bar{e} \equiv e/(P^{*}/P) = (Q/Q^{*})^{\theta}$. Initially, the greater demand for food in the home country, due to its government's added consumption, pulls in some imports, so it runs a deficit in its current account balance *CAB*.

Macroeconomic outcomes can change dramatically at dates $t = 2$ and beyond as new agents who come on the scene become free to choose in which industry to work. The choices depend on the values of the real interest rate, relative prices, and inflation rate that young agents will face over their lifetime.

In general, a higher real interest rate benefits service providers, because they are lenders, and hurts farmers, because they are borrowers. A lower relative price of services to food hurts service providers and benefits farmers. And a higher inflation rate hurts service providers, because they hold money, but has no effect on farmers, because they hold no money.

Because there is a world capital market, agents in each country face the same real interest rate. However, relative prices and inflation will be different in the two countries following the home country's policy move. Thus, the labor market choices also will be different in the two countries.

In each country, then, the higher real interest ρ that results from the home country's policy move encourages labor to move into the service-providing industry. In the home country, this incentive is overridden by a fall in relative prices Q and a rise in the inflation rate π, both of which act to encourage labor to move into farming. Thus, the net effect of the changes in ρ, Q, and π is to move labor into farming. However, in the foreign country, the changes in relative prices Q^* and inflation π^* initially are just a small fraction of the changes in Q and π, respectively, so the dominant change there is the rise in ρ. Thus, the net effect in the foreign country is to move labor into services.

The changes in labor allocations in the two countries, n and n^*, seemingly have some effect on the total amount of private borrowing and lending. However, that effect must be small because the values of the real interest rate at dates $t = 2$ and beyond are little changed from its value at $t = 1$. Similarly, the changes in n and n^* seemingly have some effect on desired money holdings in each country, but again that effect must be small since inflation rates in each country at dates $t = 2$ and beyond are little different from their values at $t = 1$. However, the changes in n and n^* do have significant effects on relative prices in each country, Q and Q^*. In the home country the movement into farming causes Q to return to close to its initial level. In contrast, in the foreign country the movement out of farming keeps Q^* permanently below its initial level.

Differences in the behavior of relative prices and inflation in the two countries have direct implications for the behavior of exchange rates. Since inflation stays higher in the home country than in the foreign country, the nominal exchange rate $e \equiv p^{f*}/p^f$ steadily declines following the home country's policy move. Since relative prices Q initially fall more in the home country than in the foreign country, the real exchange rate $\bar{e} \equiv (Q/Q^*)^\theta$ initially falls. However, since Q subsequently returns to essentially where it was while Q^* stays lower, the real exchange rate rises to a new level above where it was initially.

Finally, the home country's current account at dates $t = 1$ and $t = 2$ goes into deficit as imports rise in response to its increased demand for food. The imports are provided by the foreign country, in a sense, in the form of a loan. The interest on that loan takes the form of the home country sending food to the foreign country at dates $t = 3$ and beyond.

The behavior of ρ, Q, and π has direct implications for how higher government spending $\Delta g^f > 0$ is financed in the home country in the new steady state. It also indicates the nature of the inefficiency caused by deficit financing. Since the new steady-state Q is close to the initial Q, it cannot have a major effect on government financing. With the government being a debtor, the higher real interest rate it faces raises the interest expense on its debt. So, inflation must rise by enough to pay for both the higher government consumption and the higher interest on the debt. The inflation tax is borne directly by service providers since they hold all the money. However, labor mobility requires that after-tax returns be the same in each industry. Taken together, those facts require the pretax return to be higher in the service industry. In sum, labor mobility results in the total cost of the added government consumption being shared equally by all agents. The inefficiency of deficit financing shows up as a difference in pretax returns in the two industries.

Figures 11–14 indicate how the utilities of agents are affected by a price-support policy move at date $t = 1$. The charts indicate the differences in utility when $\Delta g^f = .04055$, $\Delta g^{f*} = 0$ and when $\Delta g^f = 0$, $\Delta g^{f*} = 0$ for agents in each sector of each economy who are born at dates $t = 0, \ldots, 8$. The initial steady-state values are represented by the zero lines, and percentage deviations from the initial steady state are represented by the diamonds.

The effects of a price-support policy move on utilities have already been suggested in the explanation of changes in n and n^*. So, just a few additional comments are necessary.

In the home country, the big winners from the price-support policy move are the initial old farmers, and the big losers are the initial old service providers. Since the old farmers have nominal debt outstanding, they benefit from an increase in the price level. And since the largest share of their food production comes in their second period of life, they also significantly benefit from a fall in Q at date $t = 1$. In contrast, old service providers, who hold both inside and outside nominal debt, lose the most by the price-support policy move, as it raises the price level. With the added government consumption causing a reduction in the private sector's supply of food, it is not surprising that the loss in utility to old service providers is greater than the gain in utility to old farmers. Generation 1 farmers are helped a little by the fall in Q at date $t = 1$. However, the majority of their production comes at date $t = 2$, when an influx of farmers drives Q back up. Generation 1 service providers are hurt a little by that policy move, but they are partly compensated by a rise in ρ. For generations born at dates $t = 2$ and beyond, their utilities are identically lower no matter in which industry they work. Taken together, those observations suggest that to justify price supports the social welfare function must favor farmers over service providers (since the former gain less than the latter lose), and it must exhibit a high rate of time discount (since all agents born at dates $t = 2$ and beyond lose).

Two observations on foreign agents' utilities merit discussion. First, their utilities are affected to a small degree compared with the utilities of analogous agents in the home country. Second, after the economies settle into a new steady state, the utilities of the foreign agents are lower than they were in the initial steady state. The first observation is due to the fact that the foreign country does not have to absorb a loss in its supply of food, whereas the home country does. The second observation is somewhat puzzling. In the new steady state, the home country sends the foreign country a steady stream of food. So the foreign country could have more food and services by shifting a small number of workers from food to service production (as compared with the initial steady state). However, it actually shifts too many and accepts an unfavorable trade-off between less food in total (home-produced and imports) and more services. That it could have generated a Pareto-improving allocation and instead generated a Pareto-reducing allocation is evidence of an inefficiency.

That inefficiency reflects the structure of this model with overlapping generations and no bequests. Because of this structure, government deficits affect the real rate of interest, which is a relative price in determining the allocation of labor, and hence production, between food and services. In an Arrow-Debreu economy, relative prices in equilibrium will ensure that consumers' marginal rate of substitution between food and services will equal the marginal rate of transformation in production. In that model, the relative price (as affected by the real interest rate) can be at a welfare-maximizing value only if government deficits are zero.

Given the parameter values chosen for this experiment, foreign agents' utility functions give equal weight to the consumption of food and services. An optimal allocation, then, would have equal supplies (production plus imports) of the two. Yet in the initial equilibrium, government deficits already are positive, which causes the real interest rate to be too high and thereby the production of services also to be too high. An increase in food consumption by the government of the home country causes a further rise in the real interest rate and in the foreign country a further move of labor into the service industry, resulting in a further move away from an optimal allocation. Apparently, the welfare-reducing effect in the foreign country of a rise in the real interest rate overwhelms the welfare-raising effect of positive imports.

B. Checks for Linearity

1. Macroeconomic Outcomes

Linearity of outcomes is examined with respect to the initial support level for a policy move of a given size and with respect to the size of the policy move for a given initial support level. Although many variables at many horizons could be examined, three variables, chosen to be representative, are examined at their steady-state values: the real interest rate ρ, the allocation of labor in the home country *n*, and aggregate consumption of food by home-country farmers in their second period of life $n \cdot c_j^i(2)$, where i = food and j = farmer. Those variables at their steady-state values seem representative given the nature of the solution. The outcomes for all variables depend on the recursive solution for seven key variables. The first of those key variables in the recursion is ρ, while n and n^* are the last. The quantity $n \cdot c_f^f(2)$ depends on all the key variables that apply to the home country. The model is solved forward, so values of variables in their steady states are solved after their values in transition.

a. Initial support level

For this exercise, two differences are compared in the values of each representative variable $X(\Delta g^f, \Delta g^{f*})$: $X(.04055,0) - X(0,0)$ and $X(.2956+.04055,.2956) - X(.2956,.2956)$, where $\Delta\hat{g}^f = .2956$ is the Nash solution. The results are summarized in the top section of the table below.[9] They indicate a high degree of linearity in this dimension.

Linearity with Respect to Initial Support Level

Variable	(1) $X(\Delta\hat{g}^f+dg^f,\Delta\hat{g}^f) - X(\Delta\hat{g}^f,\Delta\hat{g}^f)$	(2) $X(dg^f,0) - X(0,0)$	(3) $X(0,0)$	10^7* [(1)–(2)]/(3) measure of (non)linearity
ρ	.0002332	.0002328	.4187665	10
n	.0001767	.0001760	.4455460	16
$n \cdot c_f^f(2)$	.0062273	.0062033	20.7013751	12
$u^f(0)$	.0018305	.0018608	2.7359243	–111
$u^s(0)$	–.0020929	–.0020420	2.8358009	–180

b. *Size of policy move*

For this exercise, comparisons are made in outcomes for representative variables with respect to the size of the perturbations dg^f; namely $X(\Delta\hat{g}^f+2dg^f,\Delta\hat{g}^f+2dg^f) - X(\Delta\hat{g}^f,\Delta\hat{g}^f)$ and $2[X(\Delta\hat{g}^f+dg^f,\Delta\hat{g}^f+dg^f) - X(\Delta\hat{g}^f,\Delta\hat{g}^f)]$, where as before $\Delta\hat{g}^f$ is the Nash solution value and dg^f = .04055. The results are summarized in the top section of the table below, and, once again, they indicate a high degree of linearity.

Linearity with Respect to Size of Policy Move

Variable	(1) $X(\Delta\hat{g}^f+2dg^f,\Delta\hat{g}^f+2dg^f) - X(\Delta\hat{g}^f,\Delta\hat{g}^f)$	(2) $2[X(\Delta\hat{g}^f+dg^f,\Delta\hat{g}^f+dg^f) - X(\Delta\hat{g}^f,\Delta\hat{g}^f)]$	(3) $X(\Delta\hat{g}^f,\Delta\hat{g}^f)$	10^7* [(1)–(2)]/(3) measure of (non)linearity
ρ	.0009331	.0009330	.4221640	2
n	.0002914	.0002913	.4466048	2
$n \cdot c_f^f(2)$	.0123682	.0123647	20.7463387	2
$u^f(0)$	.0037349	.0037391	2.7496794	–15
$u^s(0)$	–.0042252	–.0042180	2.8206422	–26

2. Welfare

To be consistent with the check for linearity of macroeconomic outcomes, the check for welfare should be done with respect to steady-state values. However, it was shown in Section A on policy moves that steady-state utilities are affected relatively little by a policy move of the size considered here. Instead, the bulk of the changes in utility resulting from $\Delta g^f > 0$ are experienced by the initial old in the home country, with service providers losing more than farmers gain. Thus, to help in understanding the existence of equilibria, the utilities of the initial old are examined in the tables above.

The tables reveal two important results from the model. First, the utilities of the old change with respect to an increase in the price-support level in a more nonlinear way than do macroeconomic outcomes—by a factor of roughly 10. Second, as the level of price supports rises, old farmers gain progressively less in utility and service providers lose progressively more in utility. Both implications follow from diminishing marginal utility.

C. Properties of Equilibria

1. Existence of Game Solutions

Based on the approximate linearity of macroeconomic outcomes and steady-state utilities with respect to policy moves, the existence of bounded solutions to policy games becomes an issue. However, it has been shown that the changes in sums of generational utilities are dominated by the changes in the utilities of the initial old. Because of diminishing marginal utilities, as the level of price supports rises, the initial farmers gain progressively less in terms of utility while the initial service providers lose progressively more. Those responses ensure that government consumption of food will be strictly less than the total supply no matter which game is being played.

2. Nash Versus Cooperative Solutions

It has been reported that the Nash solution values $\Delta\hat{g}^{f} = \Delta\hat{g}^{f*}$ are .2956 and the cooperative solution values $\Delta\hat{\hat{g}}^{f} = \Delta\hat{\hat{g}}^{f*}$ are .3767. A question is, Why do the countries have a higher level of price supports when they cooperate than when they don't?

The answer is there must be a positive externality from one country's policy move reflected in the other country's total welfare. In fact, for the cooperative level of price supports to exceed the Nash level, the loss in welfare to the home country from a small increase in price supports from their Nash level must be exceeded in absolute value by the gain in foreign welfare. In order to see this, consider the three equilibria:

I.	$\Delta g^{f} = \Delta\hat{g}^{f}$, $\Delta g^{f*} = \Delta\hat{g}^{f*}$,	Nash
II.	$\Delta g^{f} = \Delta\hat{g}^{f} + dg^{f}$, $\Delta g^{f*} = \Delta\hat{g}^{f*}$,	policy move from Nash in home country only, with $dg^{f} = \varepsilon > 0$, small.
III.	$\Delta g^{f} = \Delta\hat{g}^{f} + dg^{f}$, $\Delta g^{f*} = \Delta\hat{g}^{f*} + dg^{f}$,	policy moves from Nash in both countries with dg^{f} defined as before.

Let $W(\Delta g^{f},\Delta g^{f*}) \equiv W(1)$ evaluated at the indicated levels of price supports. Then,

(1) $W(\Delta\hat{g}^{f}+\varepsilon,\Delta\hat{g}^{f}+\varepsilon) - W(\Delta\hat{g}^{f},\Delta\hat{g}^{f}) > 0$ since

$$\Delta\hat{\hat{g}}^{f} > \Delta\hat{g}^{f}+\varepsilon$$

We can write (1) as

(1) $[W(\Delta\hat{g}^{f}+\varepsilon,\Delta\hat{g}^{f}+\varepsilon) - W(\Delta\hat{g}^{f}+\varepsilon,\Delta\hat{g}^{f})] + [W(\Delta\hat{g}^{f}+\varepsilon,\Delta\hat{g}^{f}) - W(\Delta\hat{g}^{f},\Delta\hat{g}^{f})]$.

For small changes ε, we know the model is approximately linear. The first difference would be little changed if the initial support level in the home country were $\Delta\hat{g}^f$ rather than $\Delta\hat{g}^f + \varepsilon$. Hence, (1) as rewritten is approximately equal to

$$(2)\quad [W(\Delta\hat{g}^f,\Delta\hat{g}^f+\varepsilon) - W(\Delta\hat{g}^f,\Delta\hat{g}^f)] + [W(\Delta\hat{g}^f+\varepsilon,\Delta\hat{g}^f) - W(\Delta\hat{g}^f,\Delta\hat{g}^f)].$$

Since the two countries are identical, the first difference, which measures the change in the home country's welfare from a foreign policy move, must be the same as the difference in foreign welfare $W^*(1)$ from a policy move in the home country. So, finally, we can write (2) as

$$(3)\quad [W^*(\Delta\hat{g}^f+\varepsilon,\Delta\hat{g}^f) - W^*(\Delta\hat{g}^f,\Delta\hat{g}^f)] + [W(\Delta g^f+\varepsilon,\Delta\hat{g}^f) - W(\Delta\hat{g}^f,\Delta\hat{g}^f)].$$

Refer to the differences as (3a) and (3b), respectively. We know (3b) < 0 by the definition of a Nash solution. But then (3a) + (3b) = (1) > 0 ⇒ (3a) > –(3b), or at the Nash equilibrium, the gain in foreign welfare from a policy move in the home country more than offsets the loss in welfare in the home country. The intuitive explanation for that result is that the foreign country benefits from the home country's government consuming food each period, but the foreign country does not directly bear the cost of that consumption.

We verify these relationships for equilibria I, II, and III in the model for $dg^f = \frac{1}{2}[\Delta\hat{\hat{g}}^f - \Delta\hat{g}^f] = .04055$.

Differences in Welfare for Alternative Equilibria

Differences in Welfare from I ($*10^7$)	Equilibria I $\Delta g^f = \Delta g^{f*} = .2956$	 II $\Delta g^f = .33615$ $\Delta g^{f*} = .2956$	 III $\Delta g^f = \Delta g^{f*} = .33615$
$W(1)$	0	–28	82
$W(1)^*$	0	110	82

3. Macroeconomic Outcomes Under the Two Games

Without explicitly describing the Nash and cooperative macroeconomic outcomes, some of their main features will be reported here with reference to the section on policy moves. These features derive from three simple deductions. First, since the economies are initially identical, the levels of price support in the Nash and cooperative solutions, $\Delta\hat{g}^f$ and $\Delta\hat{\hat{g}}^f$, respectively, will be the same in each country, so the economies will continue to be identical after the price-support policies are in place. Second, the only difference in the two game solutions is in the common level of price-support levels they imply. Thus, the macroeconomic effects in the two games will be qualitatively the same, but the effects will be quantitatively larger for the cooperative game because it implies a quantitatively larger level of price supports. Third, again because the economies are initially identical, the effects of a joint policy move $\Delta g^f = \Delta g^{f*} > 0$, which includes both the Nash and cooperative equilibria moves, can be determined from the effects of a single country's policy move $\Delta g^f > 0$. Those effects are reported below.

Since the model is approximately linear with respect to macroeconomic outcomes in the sense described earlier, the effects of a joint policy move are essentially additive with respect to the effects of a single country's policy move. In particular, for the real interest rate, the rise due to a joint move will be approximately twice the rise due to a single country's move. Thus, the time profile of the real interest rate deviations from initial steady state will be qualitatively the same for joint- or single-country moves. For other variables X, which have counterparts in each country, the change in $X = X^*$ due to $\Delta g^f = \Delta g^{f*}$ is approximately equal to the sum of the changes ΔX and ΔX^* due to Δg^f. That is, $\Delta X/\Delta g^f + \Delta X/\Delta g^{f*} \approx \Delta X/\Delta g^f + \Delta X^*/\Delta g^f$. For example, the change in relative prices $Q = Q^*$ due to $\Delta g^f = \Delta g^{f*}$ is about equal to $\Delta Q/\Delta g^f + \Delta Q^*/\Delta g^f$. Thus, if the changes with respect to Δg^f are in the same direction, the effects of a joint move also will be in the same direction. If the changes are in the opposite direction, the effects of a joint move will depend on the relative size of the opposing changes.

The effects of a joint policy move are described briefly for the X variables:

$\underline{Q = Q^*}$. For the first two dates, $\Delta Q/\Delta g^f$ and $\Delta Q^*/\Delta g^f$ were reinforcing, so $(\Delta Q = \Delta Q^*)/(\Delta g^f = \Delta g^{f*})$ declines more sharply than either change with respect to Δg^f. For later dates, $\Delta Q/\Delta g^f$ returned to close to zero while $\Delta Q^*/\Delta g^f$ remained negative. Thus, for later dates, $(\Delta Q = \Delta Q^*)/(\Delta g^f = \Delta g^{f*})$ approximates the declines $\Delta Q^*/\Delta g^f$.

$\underline{\pi = \pi^*}$. The effects $\Delta\pi/\Delta g^f$ and $\Delta\pi^*/\Delta g^f$ were positive for each date, so the effects $(\Delta\pi = \Delta\pi^*)/(\Delta g^f = \Delta g^{f*})$ are positive at each date and a sum of the single-country-move effects. (Recall that at date $t = 0$, $\Delta\pi = \Delta\pi^*$ is the change in the price level.)

$\underline{n = n^*}$. For dates 2 and beyond, $\Delta n/\Delta g^f$ rose by more than $\Delta n^*/\Delta g^f$ fell. Thus, for dates 2 and beyond, $(\Delta n = \Delta n^*)/(\Delta g^f = \Delta g^{f*})$ rises by somewhat less than $\Delta n/\Delta g^f$.

$\underline{e, \bar{e}, CAB}$. For each variable, the sum of the effects across countries from Δg^f net out to zero, so the effects of a joint policy move must also be zero. Another way of seeing this is that since the countries are identical both before and after the joint policy moves, it follows that both before and after the joint policy moves $e = 1$, $\bar{e} = 1$, and $CAB = 0$.

III. Interaction Between Price-Support and Monetary Policies

We begin this section by briefly reviewing the macroeconomic effects in the Chin-Miller model of a tightening in monetary policy in the home country when price-support policies are not free to respond. In other words, between monetary policy and this special form of budget policy, it is assumed that monetary policy makes the last move. We then compare the outcome of this policy experiment to one for which price-support policies are free to respond to a tightening in the home country's monetary policy; that is, it now is assumed that this special form of budget policy makes the last move. The comparison for a few key variables demonstrates that which policy makes the last move importantly affects the outcomes.

A tightening in the home country's monetary policy (a rise in β) at date $t = 1$ is an open-market sale that increases the world's supply of bonds and initially decreases the home country's stock of money. The increase in the world's supply of bonds leads to a rise in the real interest rate ρ. The decline in money leads to a fall in the home country's price level $P(1)$. The fall in price level in the home country makes it relatively wealthier than the foreign country. With more wealth, home country agents demand both more food and more services. However, only food consumption can be increased (by importing more), whereas service production is fixed. In order to be satisfied with the resulting consumption bundle of more food and the same services, the price of services must rise relative to food.

After date $t = 1$, inflation rises in both countries to finance a higher interest expense on government debt. However, inflation rises more in the home country since its government's interest expense rises not only because of a rise in the world's real interest rate but also because of an increase in the stock of bonds outstanding following the open-market sale. Thus, the wealth of the foreign country eventually exceeds the wealth of the home country, and the effects on relative prices, exchange rates, and current account balance eventually reverse. In terms of labor market allocations, the rise in the real interest rate dominates, so in the home country there is a shift in workers from farming into services.

The effects of a monetary policy tightening, $\Delta\beta > 0$, when price-support policies do not respond, $\Delta g^f = \Delta g^{f*} = \Delta\hat{g}^f(\beta_0, \beta_0^*)$, are compared in Figures 15–19 with the effects of $\Delta\beta > 0$ when price-support policies do respond. That is, the Nash equilibrium values of Δg^f and Δg^{f*} are solved for again based on $\Delta\beta > 0$ and $\Delta\beta^* = 0$ so that $\Delta g^f = \Delta\hat{g}^f(\beta_0 + \Delta\beta, \beta_0^*)$ and $\Delta g^{f*} = \Delta\hat{g}^{f*}(\beta_0 + \Delta\beta, \beta_0^*)$.

A change in only one country's monetary policy means that the two economies are no longer identical. That asymmetry causes the responses of price-support policies to differ in the two countries. For this numerical experiment, it is found that the g^f response is positive whereas the g^{f*} response is marginally negative.

When price-support policies respond to a tightening of monetary policy, they make the effect of the latter on the price path perverse (see Figure 15). When they do not respond, a tightening of monetary policy in the home country lowers its price level but raises its rate of inflation. Thus, for a number of periods the price path will be lower with the monetary policy tightening but eventually will move higher and higher above the initial path. However, when price-support policies do respond, the price level is not lowered and the inflation rate is moved higher at every date compared with the no response case. Thus, when they do respond, a tightening in monetary policy does not lower the price path at any date.

When price-support policies respond, they reverse the effects of a monetary policy tightening on relative prices at date $t = 1$ (see Figure 16). At that date, a tightening of monetary policy with no response from price-support policies causes the price of services to rise relative to the price of food as relatively wealthier home country agents demand both more food and more services but have to be satisfied with only more food. However, when price-support policies do respond, they wipe out the relative wealth effect stemming from disparate price level movements in the two economies. And the increased demand for food resulting from additional government consumption leads to a fall in the relative price of services to food at every date.

When price-support policies respond, they reverse the change in labor allocation in the home country at every date following a monetary policy tightening (see Figure 17). When there is no response, the dominant effect of a monetary tightening (in terms of labor allocation decisions) is a rise in the real interest rate. This effect causes a shift in workers from food to services. However, when price-support policies do respond, the dominant effect is a rise in the rate of inflation, which causes a shift in workers from services to food.

The different behavior of the real exchange rate, depending on whether or not price-support policies respond to a monetary policy tightening, just reflects the different behavior of relative prices in the two cases (see Figure 18). An important difference is that when price-support policies do not respond, a monetary policy tightening has virtually no long-term effect on the real exchange rate. However, when they do respond, a monetary policy tightening leads to a permanent rise in the real exchange rate.

Finally, the differences in the nominal exchange rate in the two cases reflect the differences in price paths (see Figure 19). The most striking difference is at date $t = 1$. A tightening in monetary policy with no response in price-support policies leads to a steeper fall in food prices in the home country than in the foreign country. Consequently, the nominal exchange rate rises at date $t = 1$. However, when price-support policies do respond, there is virtually no difference in food price changes in either country; hence, the nominal exchange rate is virtually unchanged at date $t = 1$.

The comparisons of outcomes for these five key variables illustrate a point made long ago by Sargent (1985). He showed in a different context that when the monetary and budget authorities are playing a noncooperative policy game, the effects of monetary policy depend on which authority makes the last move.

IV. Conclusion

The model used in this paper is suitable for examining some, but not all, important effects of trade-protection policies. For instance, it allows examination of the relative quantity and price effects with respect to the traded-goods and nontraded-goods sectors, of the nominal effects flowing from changes in the government's budget and money stock, and of the transmission of effects across economies. However, it does not allow examination of the effects of trade-protection policies on efficiency as they affect specialization and comparative advantage. In the text that follows, I reason on the effects of alternative trade-protection policies in just the dimensions that are suitable for analysis with this paper's model.

Trade-protection policies generally aim to benefit agents in their economy's traded-goods sector. Thus, they tend to raise the return to those agents relative to that of agents in the nontraded-goods sector. As new workers come on the scene, there will be a shift into the traded-goods sector, which will continue until the returns post-government tax/subsidy are equated. But that means the return pre-government tax/subsidy will be higher in the nontraded-goods sector than in the traded-goods sector.

Government budget deficits will be affected differently by alternative trade-protection policies. They will increase when the government either consumes the traded good or subsidizes exports. They will decrease when the government imposes tariffs or antidumping duties. To a first approximation the government's budget deficit will be unaffected by import quotas or voluntary foreign export restrictions. When the government's monetary policy keeps the ratio of bonds to money constant, the nominal effects of alternative trade-protection policies follow directly from their effects on budget deficits.

Finally, the transmission of policy effects in this model comes essentially through two channels: the change in the world's real interest rate and the change in the real exchange rate. The effects of alternative trade-protection policies on the world's real interest rate will depend primarily on how the combined budget deficits of the world's economies are affected. The change in the real exchange rate will depend on country-specific changes in demands for or supplies of the traded good, which, in turn, depend on whether the government consumes, taxes, or subsidizes and on which economy's traded-goods sector the government intervention focuses.

The model's analysis also seems applicable to games played with respect to alternative trade-protection policies. Except for price-support policies, the alternative policies benefit the country imposing them more than they benefit the other country(ies). Thus, a noncooperative game is likely to result in the policy being used to a greater extent than it would under a cooperative game. It seems possible that for some trade-protection policies the noncooperative game could lead to one extreme of a total breakdown in trade, whereas the cooperative game could lead to the other extreme of zero use of the policies.

Notes

[1]*Economist* (1999), p. 84, and Murray (1996).

[2]Because the model assumes a single traded good worldwide, it does not address issues related to specialization and comparative advantage. Instead, it focuses on issues related to the transmission of policy effects across countries, the financing of trade policies, and the effects of those policies on labor allocation between the traded-goods and nontraded-goods sectors.

[3]See, for example, Miller (1994), introduction to Chapter III.

[4]See Chin-Miller (1998), pp. 1223–24.

[5]In a steady state, any positive level of price supports would already be incorporated into private decisions and actions and would only result in a dead-weight loss.

[6]This value of $dg^f = \Delta g^f$ was chosen to be halfway between the Nash and cooperative equilibrium values of g^f.

[7]Values of parameters assumed for the simulations in this paper are in the appendix.

[8]The differences in price levels at $t = 1$ are plotted as differences in π and π^* at $t = 0$.

[9]In order to make the measures of nonlinearity comparable, they are scaled by the values of variables in the steady state for no price supports.

Appendix

Assumed Initial Parameter Values

(Since the two economies are initially identical, only values for the home country are listed.)

Preferences: $U(c_1^s, c_1^f, c_2^s, c_2^f) \equiv \theta \log c_1^s + (1-\theta)\log c_1^f + \delta[\theta \log c_2^s + (1-\theta)\log c_2^f]$

$\theta = 0.50$
$\delta = 0.70$

Production:

$y^s(t) \equiv a_1(1-n(t))^{a_2}$ (young service provider)
$y^f(t) \equiv b_1 n(t)^{b_2}$ (young farmers)
$y^f(t+1) \equiv d_1 n(t)^{d_2}$ (old farmers)

$a_1 = 156.92$
$a_2 = 0.65$
$b_1 = 31.38$
$b_2 = 0.65$
$d_1 = 125.53$
$d_2 = 0.65$

Government Policy:

Monetary

$\beta = 0.65$
$\lambda = 0.24$

Budget

$\tau = 0.00$
$g^s = 0.27$
$g^f = 0.00$

Social Welfare:

$\delta_s = 0.70$ (social discount factor)
$\alpha = 0.62$ (weight to farmers' generational utilities)

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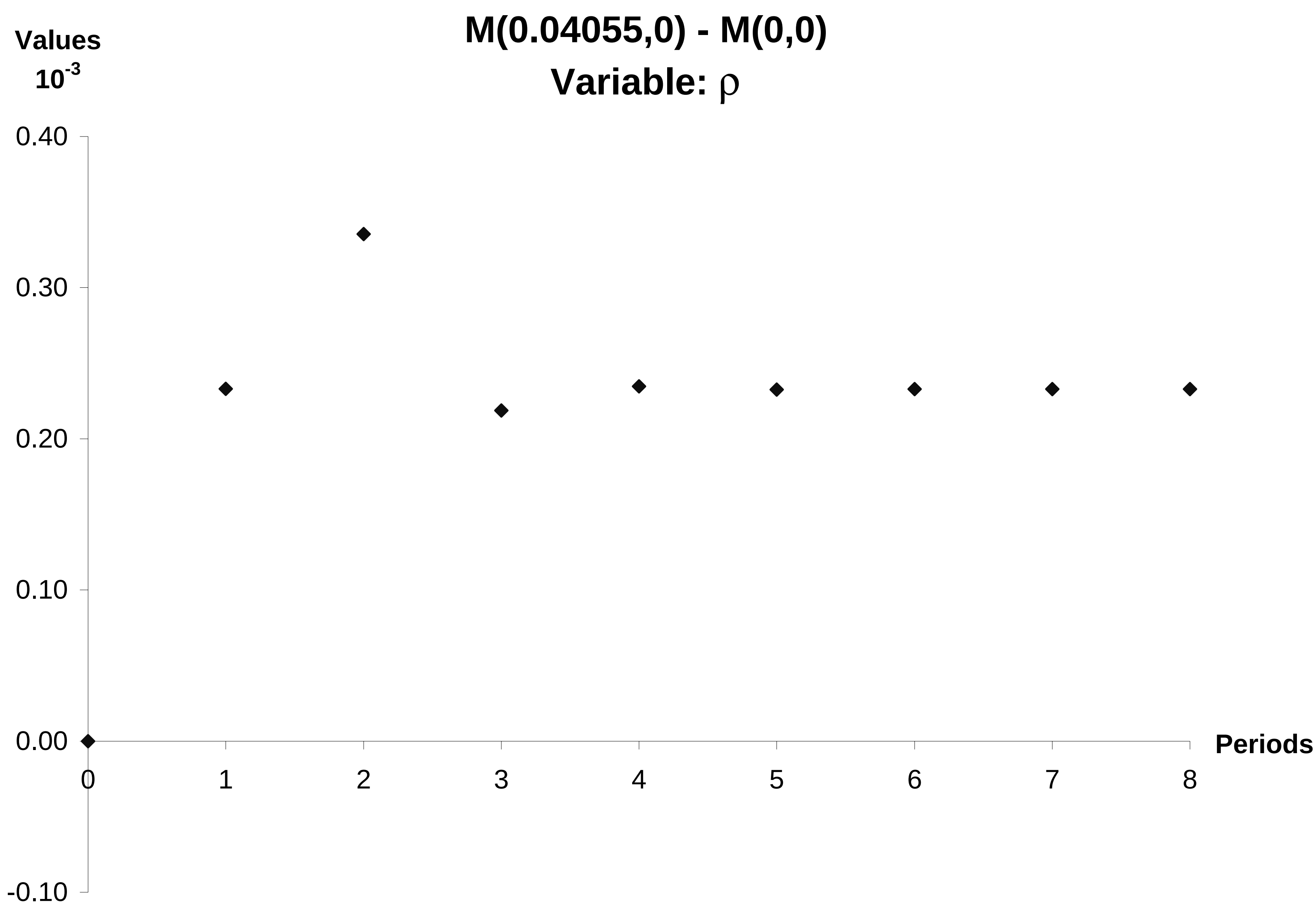
Figure 1



M(0.04055,0) - M(0,0)
Variable: ρ
Values
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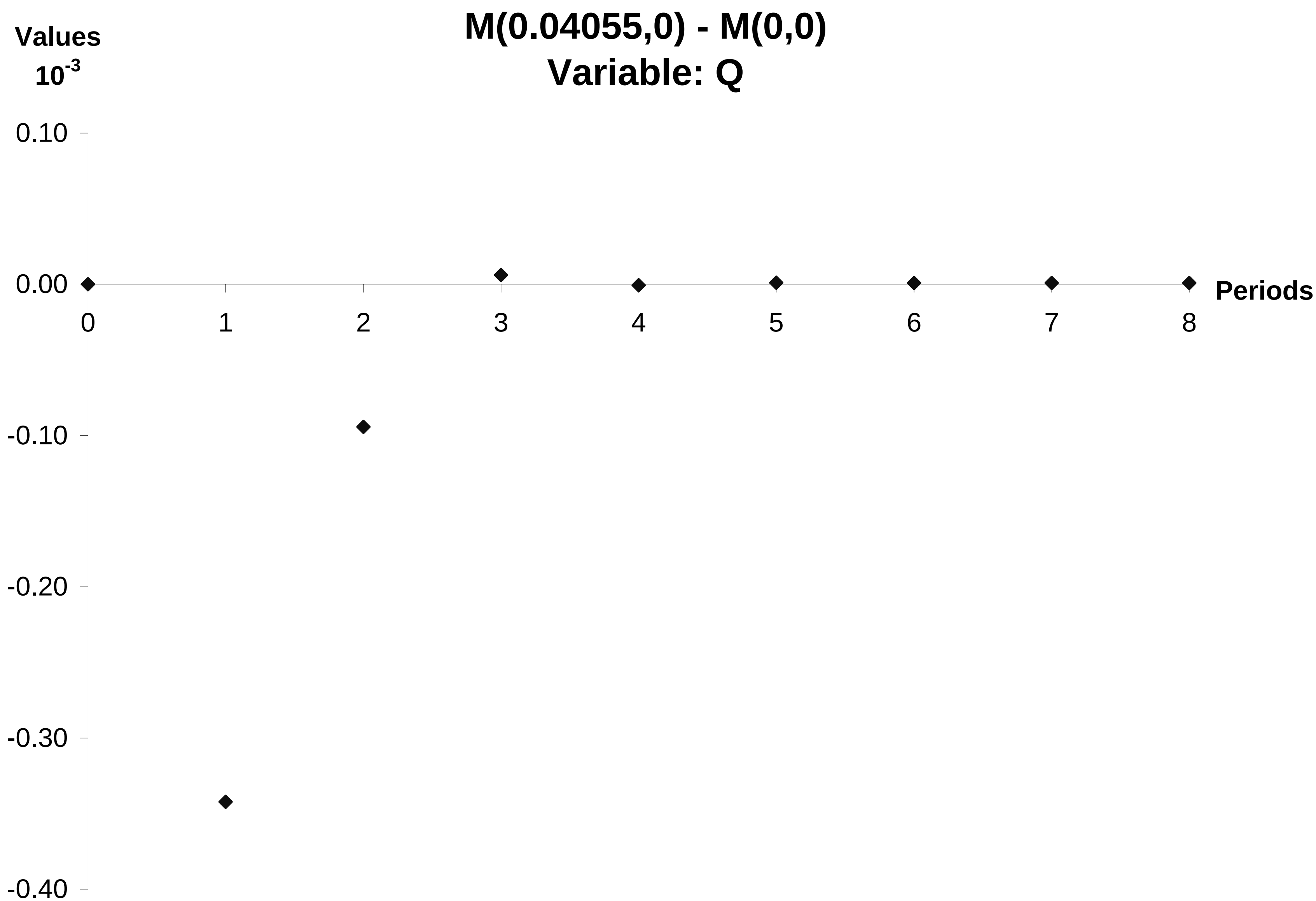
0.40
0.30
0.20
0.10
0.00
-0.10
0
1
2
3
4
5
6
7
8
Periods

Figure 2


M(0.04055,0) - M(0,0)
Variable: Q
Values
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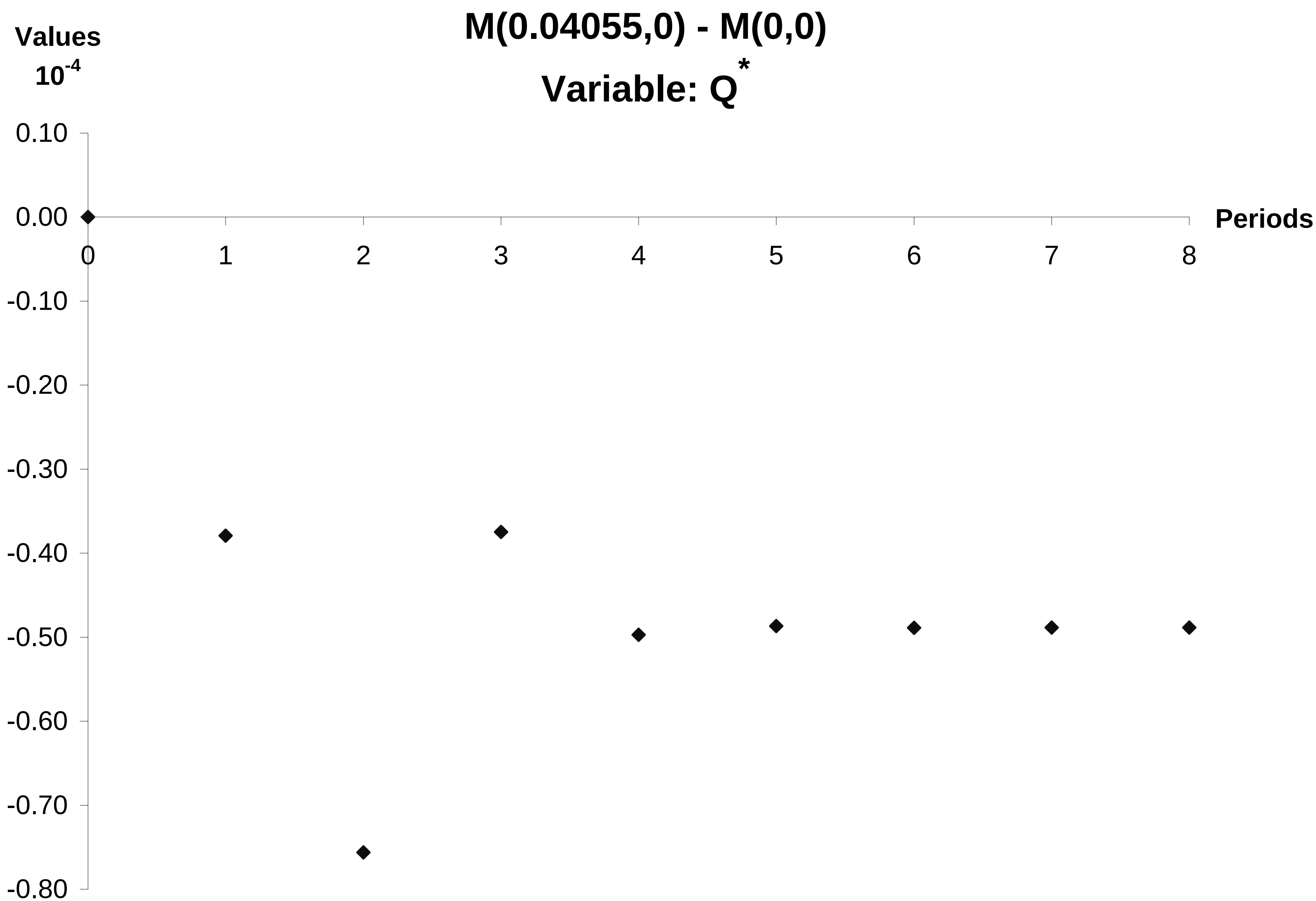
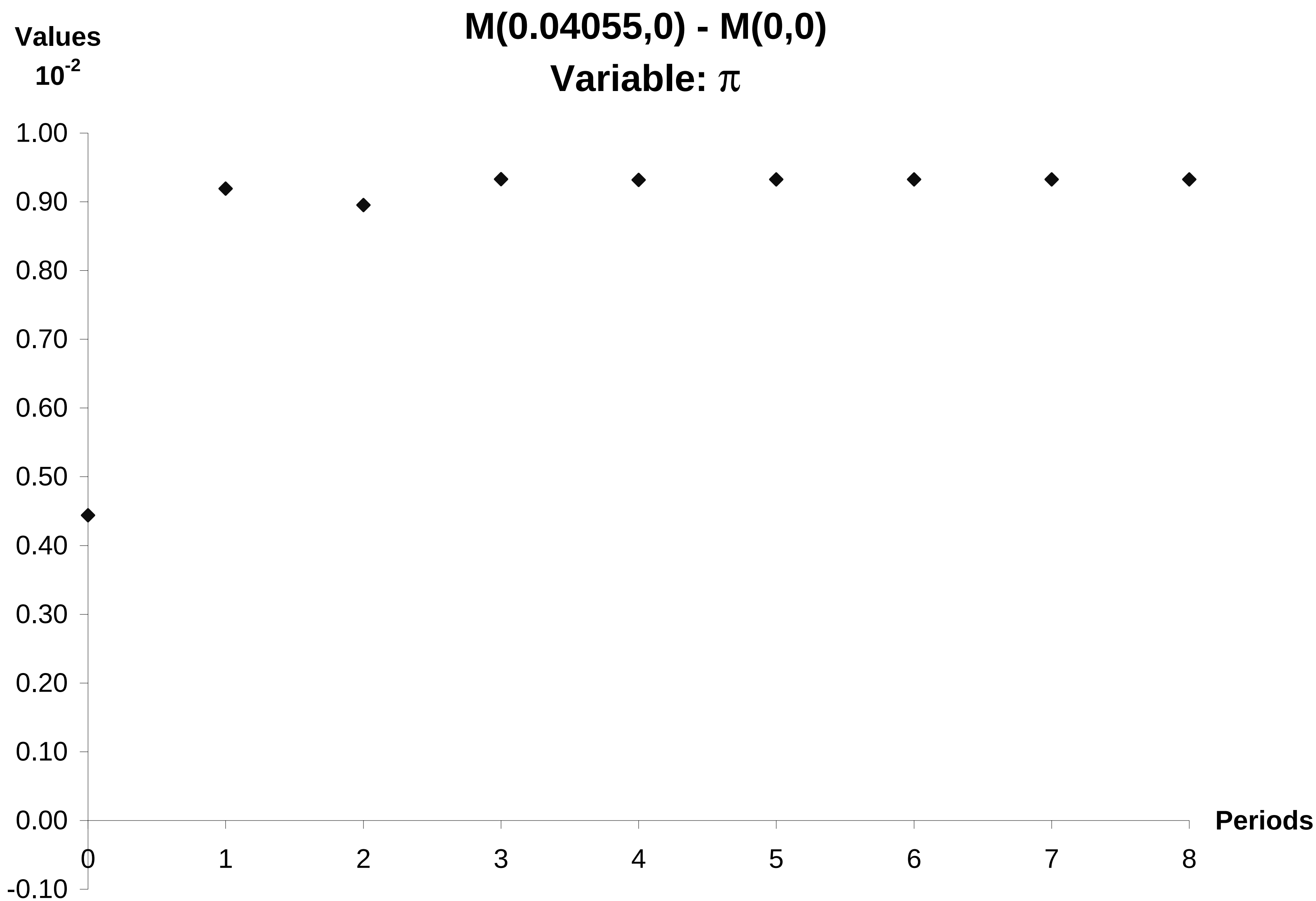
0.00
-0.10
-0.20
-0.30
-0.40
0
1
2
3
4
5
6
7
8
Periods

Figure 3



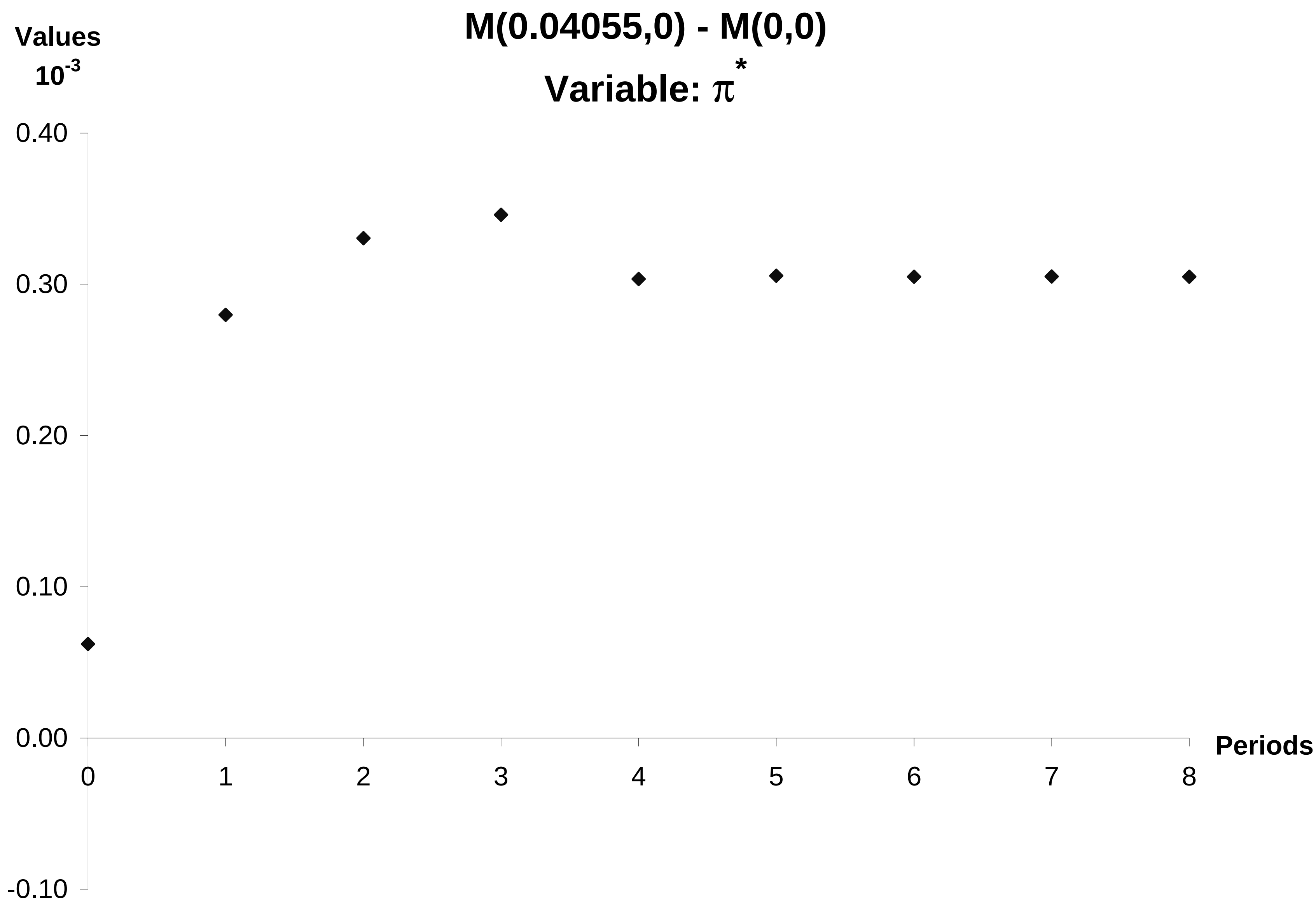
M(0.04055,0) - M(0,0)
Variable: Q*
Values
10-4
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
-0.80
0
1
2
3
4
5
6
7
8
Periods

Figure 4



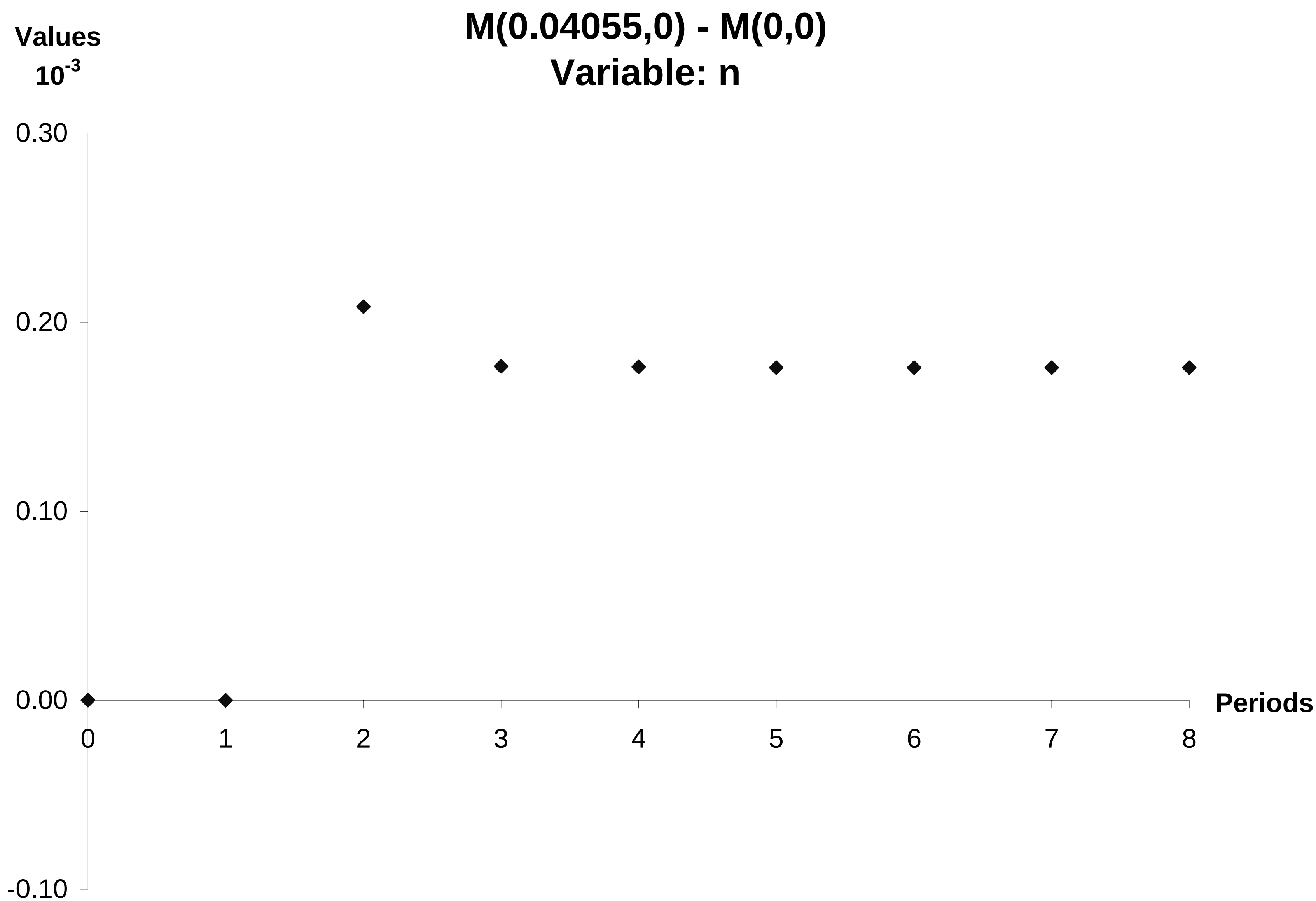
M(0.04055,0) - M(0,0)
Variable: π
Values
10^-2
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
0
1
2
3
4
5
6
7
8
Periods

Figure 5



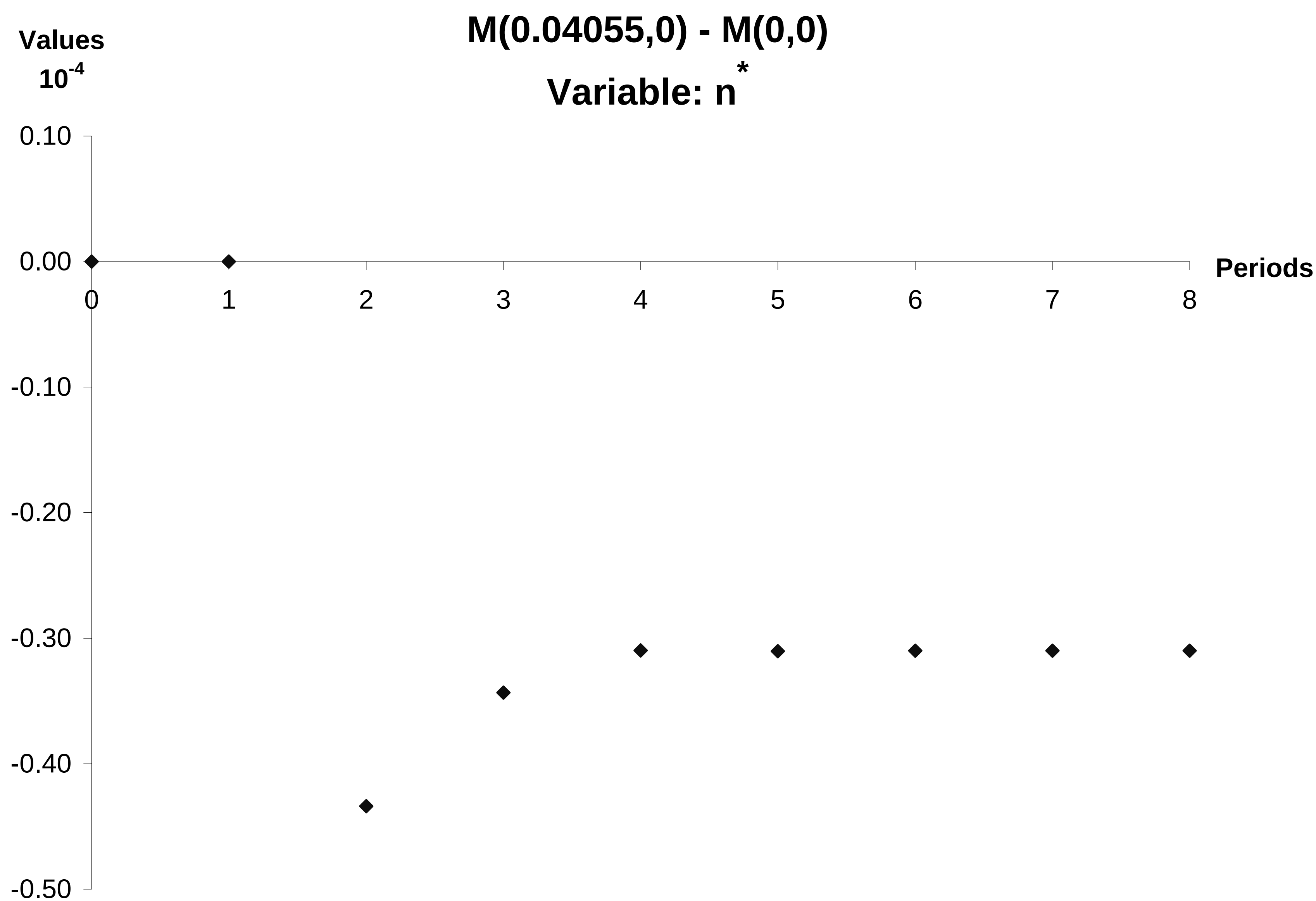
M(0.04055,0) - M(0,0)
Variable: π*
Values
10-3
0.40
0.30
0.20
0.10
0.00
-0.10
0
1
2
3
4
5
6
7
8
Periods

Figure 6



M(0.04055,0) - M(0,0)
Variable: n
Values
10-3
0.30
0.20
0.10
0.00
-0.10
0
1
2
3
4
5
6
7
8
Periods

Figure 7



M(0.04055,0) - M(0,0)
Variable: n*
Values
10-4
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
Periods
0
1
2
3
4
5
6
7
8

Figure 8

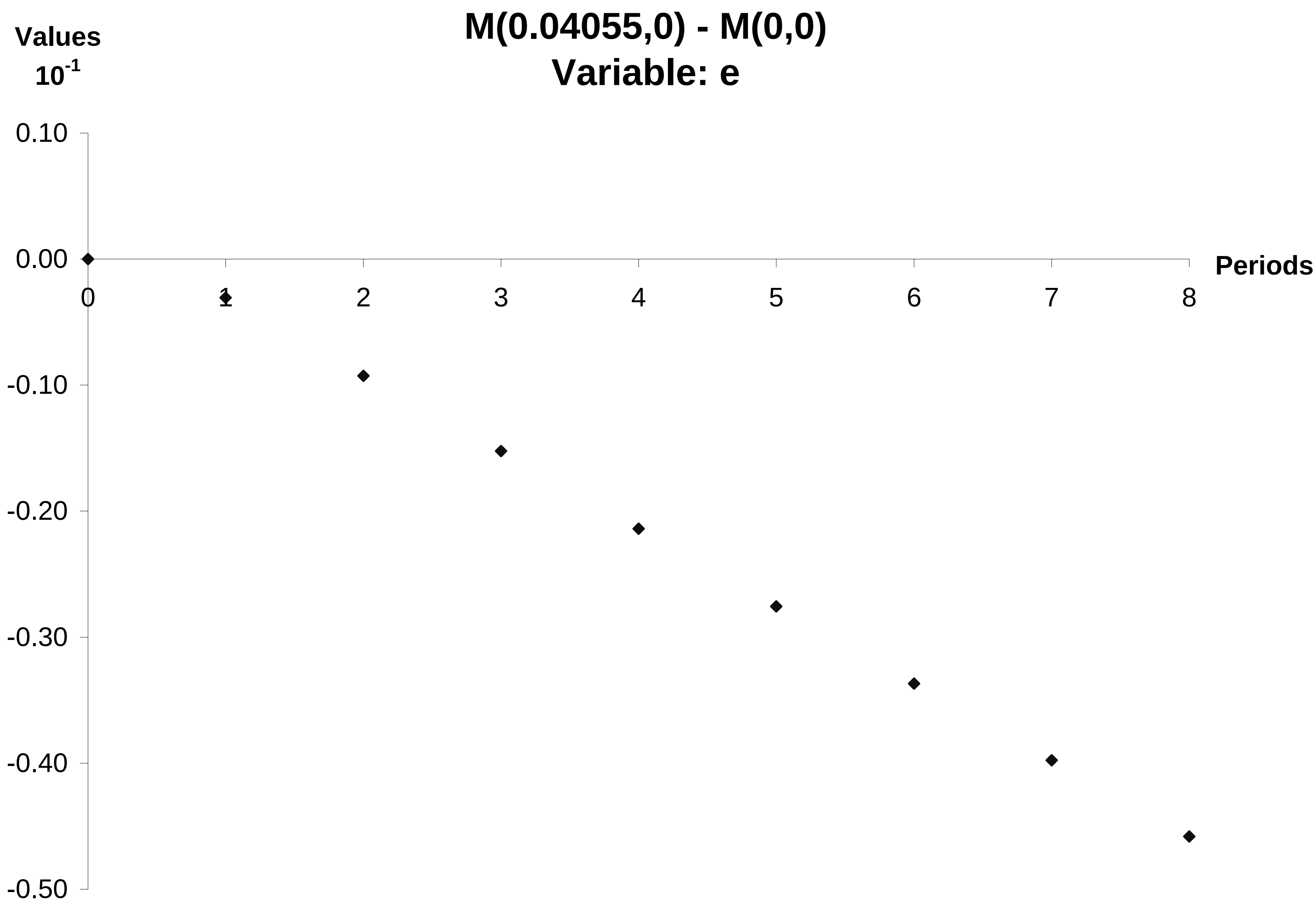
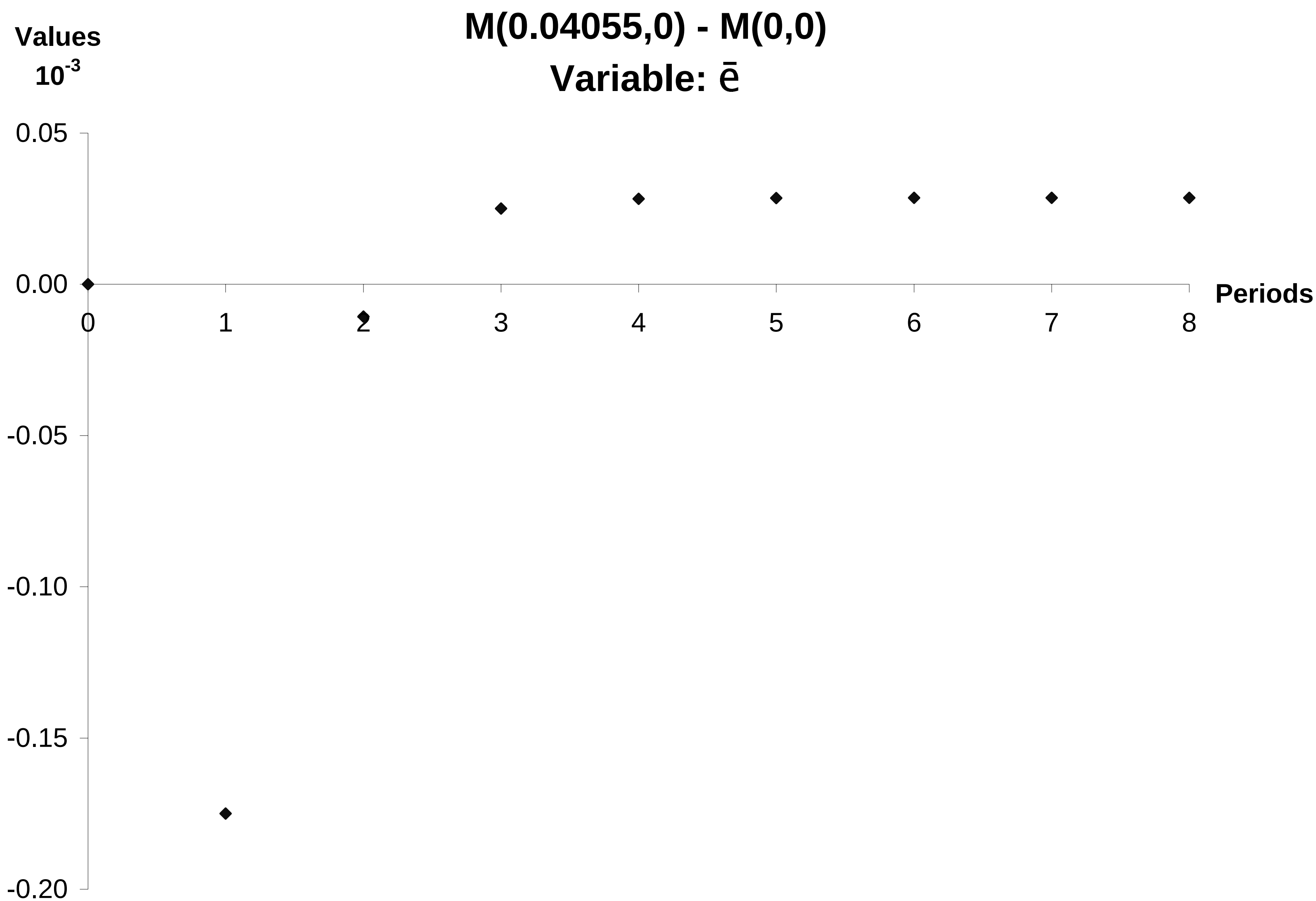
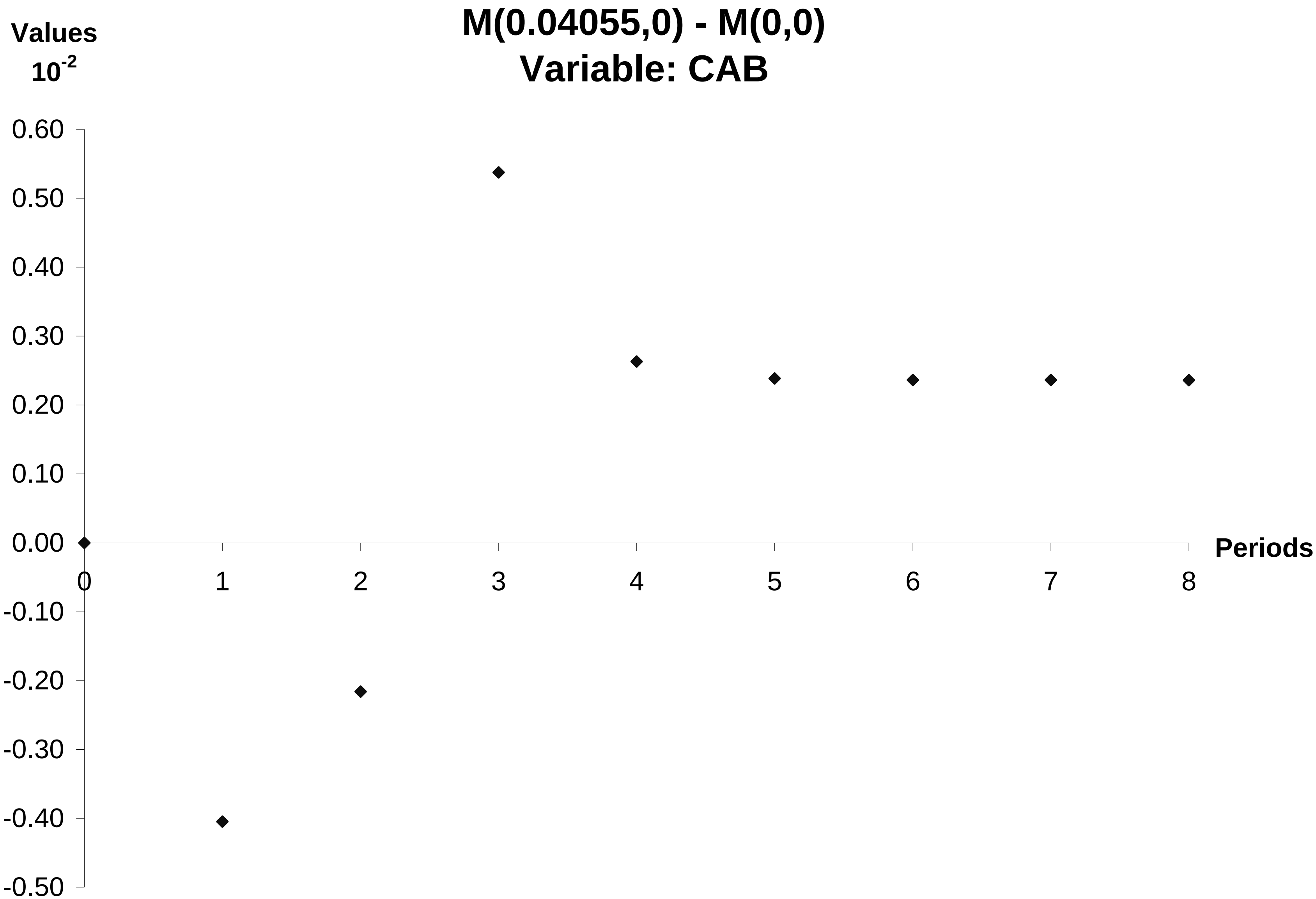

M(0.04055,0) - M(0,0)
Variable: e
Values
10^{-1}
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
Periods
0
1
2
3
4
5
6
7
8

Figure 9



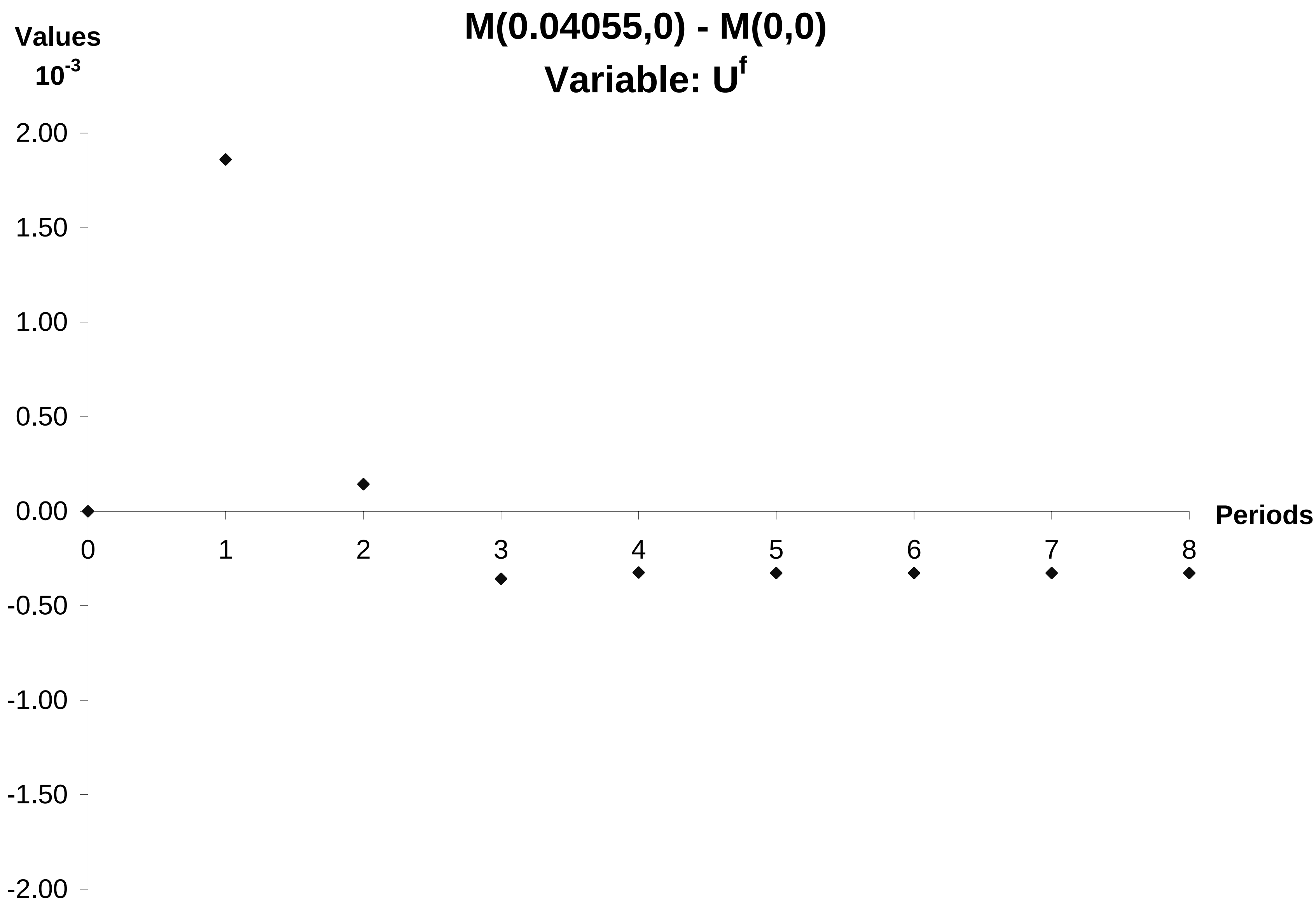
M(0.04055,0) - M(0,0)
Variable: ē
Values
10^-3
0.05
0.00
-0.05
-0.10
-0.15
-0.20
0
1
2
3
4
5
6
7
8
Periods

Figure 10



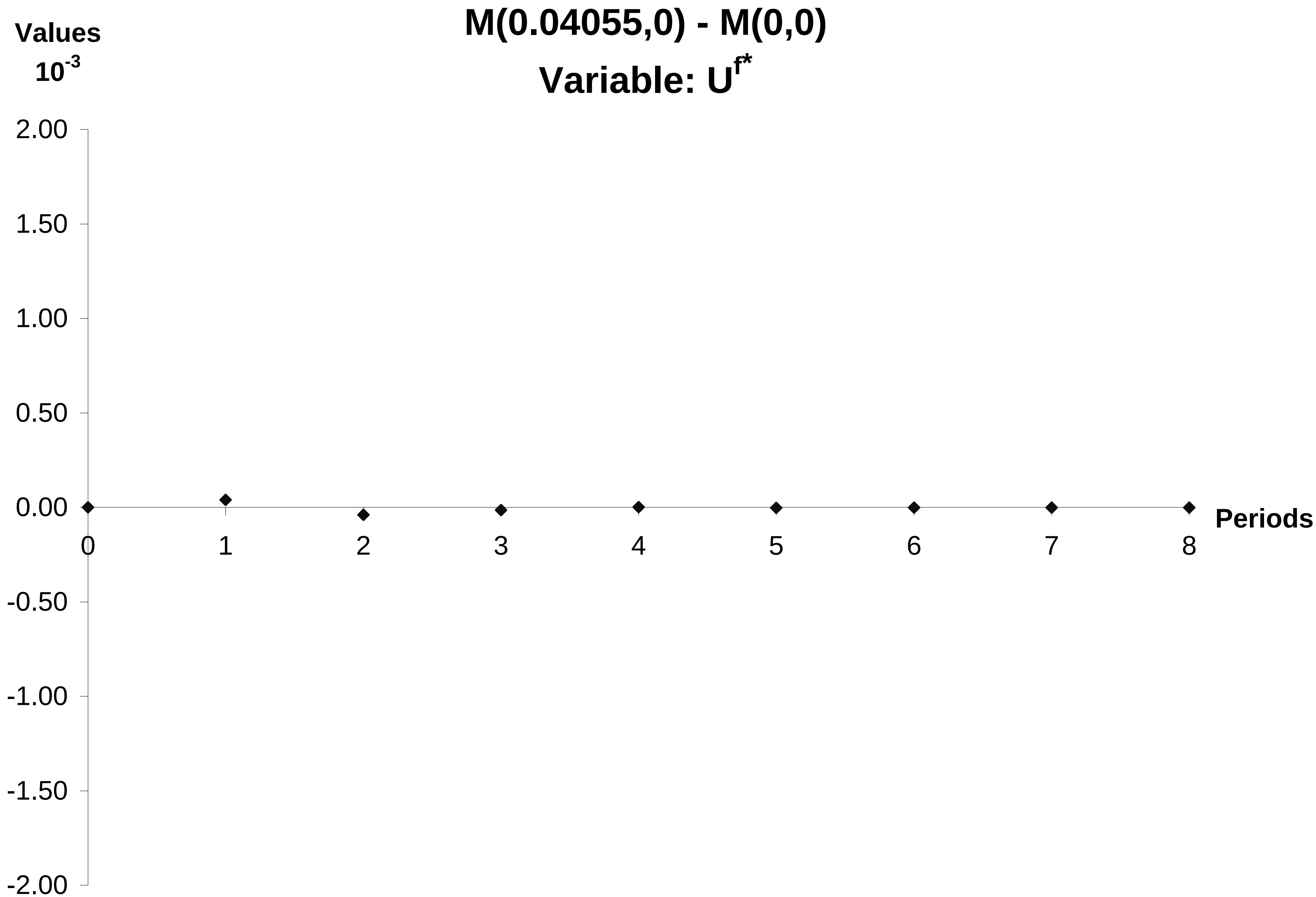
Values
10-2
M(0.04055,0) - M(0,0)
Variable: CAB
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
0
1
2
3
4
5
6
7
8
Periods

Figure 11



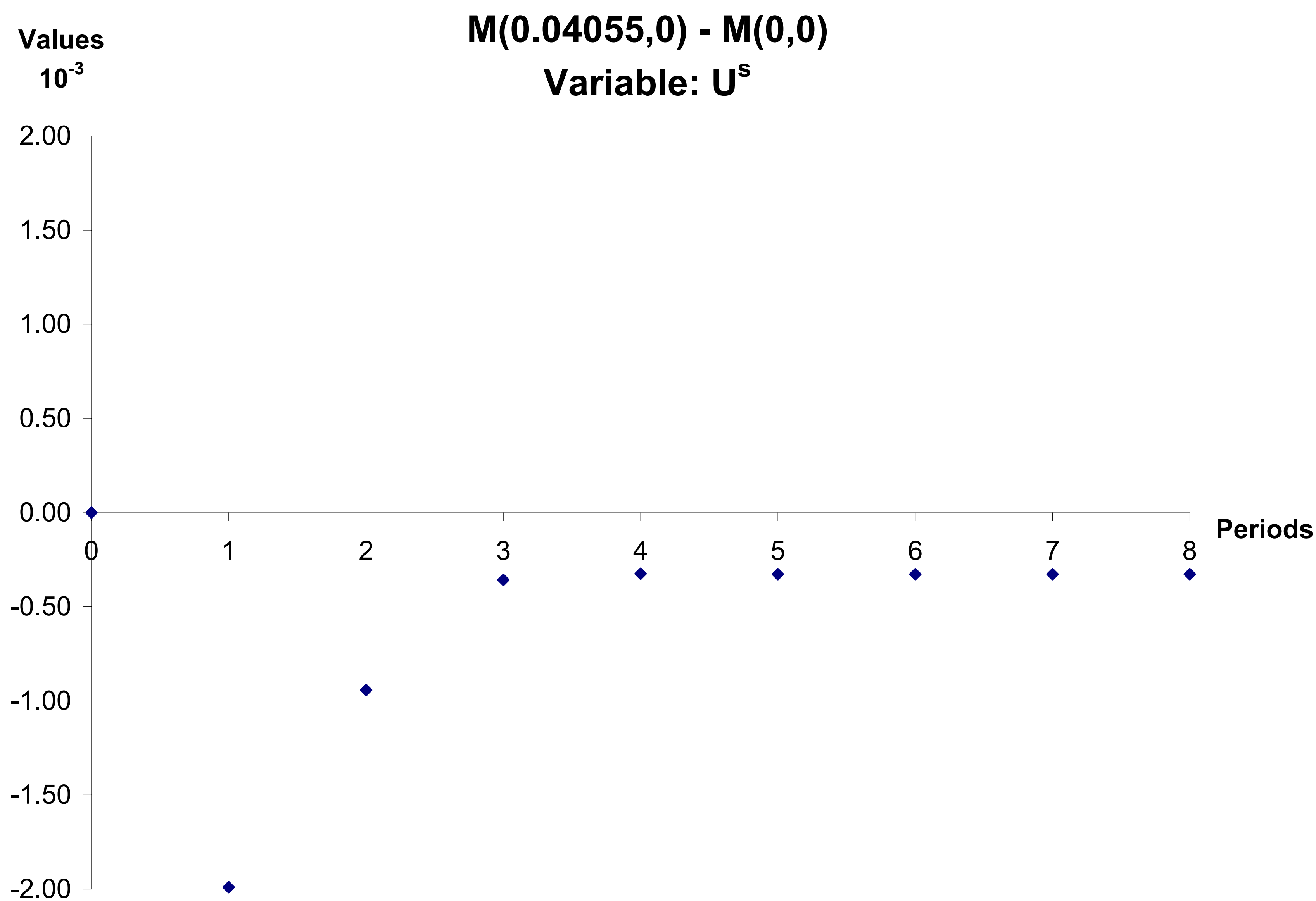
M(0.04055,0) - M(0,0)
Variable: U^f
Values
10^-3
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
Periods
0
1
2
3
4
5
6
7
8

Figure 12



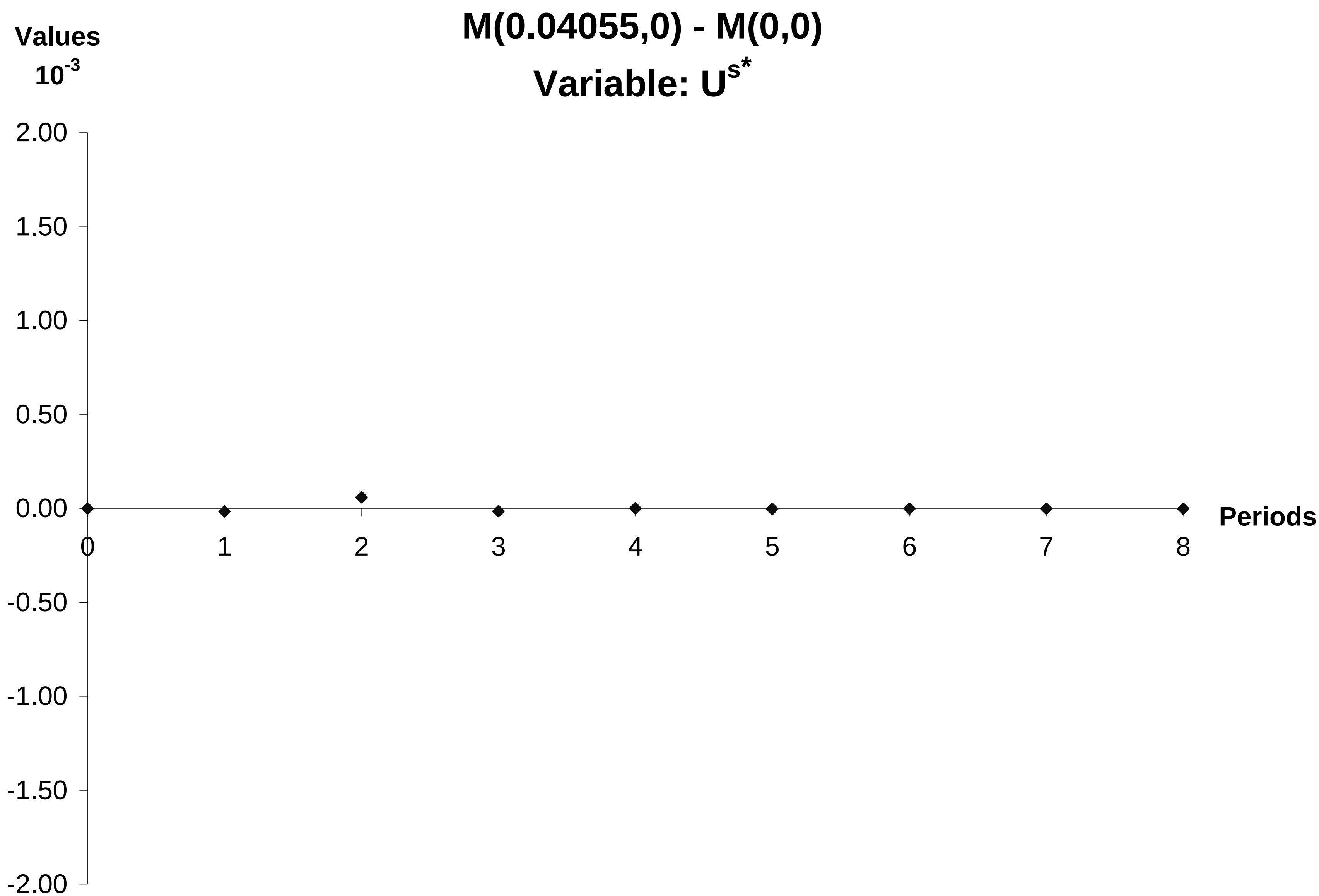
M(0.04055,0) - M(0,0)
Variable: U^f*
Values
10^-3
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
0
1
2
3
4
5
6
7
8
Periods

Figure 13



M(0.04055,0) - M(0,0)
Variable: U^s
Values
10^-3
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
0
1
2
3
4
5
6
7
8
Periods

Figure 14


M(0.04055,0) - M(0,0)
Variable: U^{s*}
Values
10^{-3}
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
0
1
2
3
4
5
6
7
8
Periods

Effects of $\Delta\beta>0$ (monetary tightening) under no price supports (dotted lines) and noncooperative supports (dashed lines)

Figure 15

π

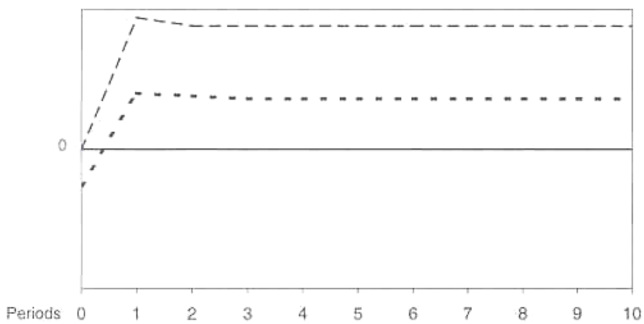


Figure 18

$\bar{e}$

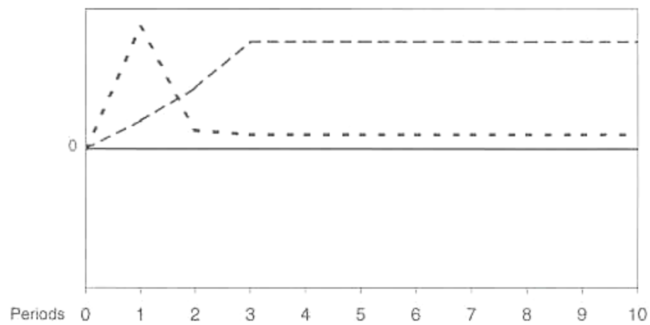


Figure 16

Q

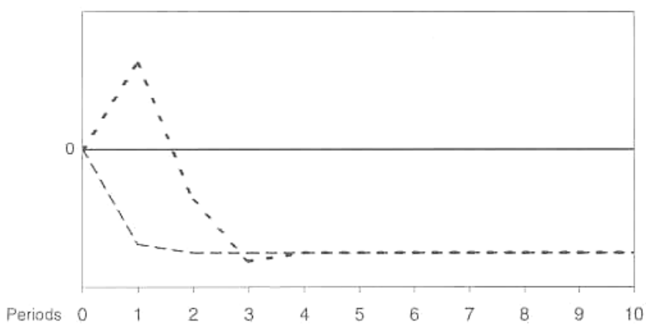


Figure 19

e

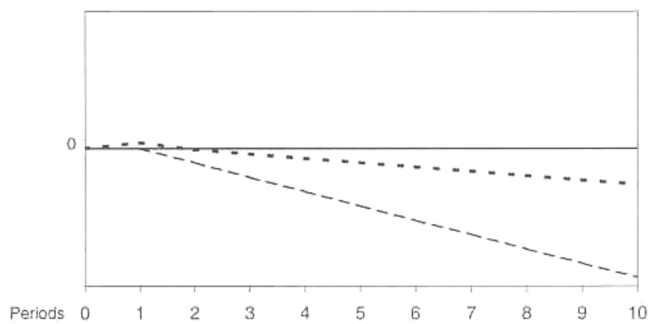


Figure 17

n