Theoretical notes on commodity prices and monetary policy[1]

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Abstract

These notes provide a non-technical introduction to recent models of monetary policy response to commodity price shocks, with emphasis on the choice between targeting the headline consumer price index vs. a measure of core prices, and the reaction to global sources of inflation when inflexible exchange rate regimes represent a source of distortion in world commodity markets.

Keywords: commodity prices, core and headline inflation, monetary policy

JEL classifications: F42, E52

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The purpose of these notes is to provide a non-technical introduction to recent models of monetary policy response to commodity price shocks. The emphasis in what follows is on the choice between targeting the headline consumer price index or rather a measure of "core" prices that excludes specific products like food and energy.

In this regard, the conventional wisdom is well summarised in a recent chapter of the IMF's World Economic Outlook that is revealingly entitled "Target what you can hit: Commodity price swings and monetary policy".[3]

Quoting directly from the report: "Because shocks to commodity price inflation are typically beyond the control of policymakers, hard to predict, and often not sustained, central banks seeking to establish credibility are generally better off setting and communicating their monetary policy in terms of underlying inflation rather than headline inflation. A headline framework may be preferred, however, if economic agents place a much higher value on the stability of headline inflation than on the stability of output."

The case for targeting core (or "underlying") inflation typically emphasises the low predictability of commodity price swings (thus the difficulty of controlling overall inflation); the long and variable monetary policy lags (such that, by the time the monetary stance is transmitted to the economy, the original shocks may have already dissipated); the nominal inertia characteristic of core prices dynamics (because of which monetary policy responses to transitory commodity price shocks have long-lasting distortionary effects on the rest of the economy, even after the original disturbances have retracted). In the simplest possible terms, the rationale for core targeting may be articulated in terms of the macroeconomic impact of this policy strategy on the national product and labour markets. In what follows we revisit the foundations of the choice-theoretic canonical model with the help of an extremely stylised, yet surprisingly insightful, algebraic and graphical apparatus.[4]

Consider the vantage point of a monetary authority unable (or unwilling) to commit to a policy rule in a commodity-importing country facing inflationary shocks. There are two kinds of consumption goods, "core" and "commodities". C is the aggregate consumption of both core goods and commodities. P is the headline price index, defined as an average of core prices, denoted P_H, and commodity prices, denoted P_F. Assuming unit elasticity of substitution between core goods and commodities[5], and defining as γ the share of core goods in consumption, we can write the consumer price index P as:

$$P = P_H^{\gamma} P_F^{1-\gamma}$$

Core goods are produced domestically with labour effort ℓ. They are either consumed locally or exported abroad in exchange for imported commodities. So in equilibrium ℓ can be "transformed" into consumption C according to the formula:

$$C = Z\ell$$

where Z is an index of relative import prices, that is, a measure of the country's terms of trade (TOT for short):

$$Z = (P_H / P_F)^{1-\gamma}$$

[3] International Monetary Fund (2011), Chapter 3.

[4] The model builds on Corsetti and Pesenti (2008), to which the reader is referred for details.

[5] This particular parameterisation is analytically convenient, even though a more realistic value for this elasticity would be well below one.

Graphically, Figure 1 summarises the macroeconomic equilibrium relations of the model as drawn in the consumption-labour (or consumption-output) space. In the figure, expression $C = Z\ell$ is a ray from the origin with slope Z. A deterioration of TOT tilts the ray downward: households need to work more to get the real income that finances the same level of consumption. From this point of view, a deterioration of TOT is isomorphic to a productivity shock.

Define now μ as the monetary stance of the country, a function of current and expected future short-term interest rates. The monetary authority controls nominal spending, so that:

$$\mu = PC$$

In Figure 1, the equation above is a horizontal line with intercept μ / P. Consumption increases when either nominal spending increases or prices fall.

Households like consumption C and dislike labour effort ℓ. The representative household's utility is:

$$U = \ln C - \ell$$

Accordingly, in Figure 1, there is a map of (negatively sloped) indifference curves. Welfare increases when we move North-West.

The initial equilibrium is represented in Figure 1 at point O. The starting allocation is characterised by full employment, and output is at its potential level $\overline{\ell}$.

As mentioned above P_F is the price of imports in terms of domestic currency. By assumption, there are no nominal rigidities in the imports (commodities) sector. Upward shocks to P_F, reflecting hikes in the prices of oil, energy, food, and other commodities, increase the price level P thus reduce the purchasing power of any given level of nominal wealth or income, and worsen the terms of trade Z.

Different from import prices, domestic prices are subject to nominal rigidities. P_H is partially sticky (with coefficient $1-\alpha$) and partially flexible (with coefficient $\alpha < 1$). The sticky component is predetermined, as it reflects past pricing decisions. The flexible component responds instead to current monetary policy, say:

$$\ln P_H \propto \alpha \log \mu + (1-\alpha) \log P_{H,-1}$$

We can summarise the above model by denoting $\widehat{X}$ as the log-deviation of any variable X from its initial equilibrium. For small shocks over the short run, the model is:

$$\hat{C} = \hat{\mu} - \hat{P}$$

$$\hat{\ell} = \hat{C} - \hat{Z}$$

$$\hat{P} = \gamma \widehat{P_H} + (1-\gamma)\widehat{P_F}$$

$$\hat{Z} = (1-\gamma)(\widehat{P_H} - \widehat{P_F})$$

$$\widehat{P_H} = \alpha \hat{\mu}$$

$$\widehat{P_F} > 0$$

Consider now the behaviour of the monetary authorities, focusing on *discretionary responses* to temporary commodity price hikes. The domestic policymakers can choose among two different monetary strategies: target core prices and stabilise P_H or target headline prices and stabilise P. As an important caveat, the policy strategies considered here are not policy rules under commitment, and the shocks under consideration are always inflationary

(positive innovations $\widehat{P_F} > 0$). Many features of this policy evaluation exercise can be extended to ex ante rules in response to commodity price volatility, but such extension is not automatic.

Under core targeting the monetary authorities choose $\hat{\mu}$ such that $\widehat{P_H} = 0$. Of course, this implies $\widehat{P_H} = \alpha\hat{\mu} = 0$: the monetary stance is unchanged, and there is no reaction to a commodity price shock. The headline CPI increases as the monetary authority tolerates (temporarily) higher headline inflation $\hat{P} = (1-\gamma)\widehat{P_F} > 0$. Consumption and real spending fall due to higher prices: $\hat{C} = -\hat{P} = -(1-\gamma)\widehat{P_F} < 0$. The terms of trade deteriorate as households pay more for their imports: $\hat{Z} = (1-\gamma)(\widehat{P_H} - \widehat{P_F}) = -(1-\gamma)\widehat{P_F} < 0$. Crucially, there is no change in domestic labour market conditions: output remains at its potential, full employment level: $\hat{\ell} = \hat{C} - \hat{Z} = -(1-\gamma)\widehat{P_F} + (1-\gamma)\widehat{P_F} = 0$. The new equilibrium is plotted in Figure 2, as the economy moves downward from O to C.

Under headline targeting the monetary authority does not tolerate higher CPI inflation, so core prices need to fall and offset the increase in commodity prices leaving $\hat{P} = \gamma\widehat{P_H} + (1-\gamma)\widehat{P_F} = 0$. Thus, the monetary stance contracts to bring down core prices. The more sticky are core prices (the lower is α), the more contractionary is the monetary stance:

$$0 = \gamma\alpha\hat{\mu} + (1-\gamma)\widehat{P_F} \Rightarrow \hat{\mu} = -\frac{1-\gamma}{\gamma\alpha}\widehat{P_F} < 0$$

Consumption and real spending fall due to lower nominal spending. Note that they fall by more than under core targeting: $\hat{C} = -(1-\gamma)\widehat{P_F} / (\gamma\alpha) = \hat{\mu} - \hat{P} < 0$. The terms of trade deteriorate because both import prices increase and core (and export) prices fall. As a result, TOT deterioration is worse than under core targeting: $\hat{Z} = (1-\gamma)(P_H - P_F) = -(1-\gamma)\widehat{P_F} / \gamma < 0$. The fall in consumption leads to a fall in demand for labour effort. Also, as terms of trade deteriorate, households need to work more to maintain the same level of consumption. With sticky prices ($\alpha < 1$) the first effect prevails upon the second, and labour effort falls below full employment level:

$$\hat{\ell} = \hat{C} - \hat{Z} = -\frac{1-\gamma}{\gamma}\left(\frac{1}{\alpha} - 1\right)\widehat{P_F} < 0$$

In Figure 2 the economy moves from O to H. Point H lies below and to the left of C.

To recapitulate: under core targeting, consumption falls a bit, headline inflation increases a bit, but output remains at potential; under headline targeting, consumption falls a lot, headline inflation does not change, output falls below potential.

Which policy response provides a better outcome?

There is an obvious welfare metrics, ie the utility of the representative household. Normalising full-employment output $\bar{\ell}$ to one, we can write:

$$dU = \frac{dC}{C} - \bar{\ell}\frac{d\ell}{\ell} = \hat{C} - \hat{\ell} = \hat{Z}$$

so that the deterioration of the terms of trade provides an appropriate measure of social welfare loss. The caveat here is that the focus in this analysis is on an *ex-post* measure of welfare, assessed after the inflationary shock has materialised, and taking previous pricing decisions (reflecting market expectations) as given.

In this case, under core targeting the terms of trade worsen by:

$$\hat{Z} = -(1-\gamma)\widehat{P_F}$$

and under headline targeting the terms of trade worsen by:

$$\hat{Z} = -\frac{(1-\gamma)}{\gamma}\widehat{P_F}$$

Unambiguously, TOT fall more under headline than core targeting. In welfare terms, households are better off under core targeting (as some increase in leisure under headline targeting does not compensate for the larger fall in consumption).

Is there a case for headline targeting at all? The analysis above, focused on the role of the terms of trade as a synthetic measure of social welfare, suggests that headline targeting may be the appropriate discretionary response to unexpected *reductions* in commodity prices, opening the intriguing possibility that the appropriate monetary strategy may be an asymmetric response to commodity price hikes and falls.

For a different approach, in the Appendix below we consider a variant of the previous model. The main result of this variant, in a nutshell, is that when exchange rate pass-through to import prices is sufficiently high relative to domestic price (wage) rigidities, there may be a case for responding (discretionally) to commodity price hikes by stabilising headline rather than core prices. To the extent that open emerging market (EM) economies are more likely to meet these requirements, headline targeting may end up providing a more appropriate policy response in these countries than in advanced economies.

In the recent literature, this line of thought is the analytical underpinning of more sophisticated refinements and model extensions that use a theoretical framework whose kernel is similar to our previous model. Two papers are worth mentioning in particular.

Anand and Prasad (2010) consider a model with financial frictions: consumers are credit-constrained, demand is insensitive to interest rate fluctuations, and determined by real wages which depend on prices in the flexible price sector (commodities). The central bank finds it appropriate to stabilise price movements in the flexible price sector, by adopting a flexible headline inflation targeting regime. According to the authors, these results are "particularly relevant for emerging markets, where the share of food expenditures in total consumption expenditures is high and a large proportion of consumers are credit-constrained".

Catão and Chang (2010) argue that a broad CPI targeting strategy is welfare-superior to alternative policy rules once the variance of food price shocks is appropriately accounted for. This is because TOT and real exchange rate move in opposite directions: food price shocks reduce TOT but, different from the canonical model, increase the cost of home consumption relative to abroad.

A more complex variant of the core versus headline targeting dilemma emerges in a multi-country setting. Let's return to the original vantage point of an advanced economy facing commodity price shocks. Underlying the model above was the implicit notion that commodity price shocks reflect fundamental factors, say growing commodity-intensive consumption of EM populations facing supply bottlenecks as the existing investment in infrastructure to supply commodities is inadequate to keep pace with growth in demand. In this case there are frequent commodity price spikes as demand must be rationed given constrained supply. Also, the underlying demand/supply factors abroad are independent of the monetary policy undertaken in the advanced economy.

But what would happen if excess demand in commodity markets reflected an excessively expansionary global policy stance, under the assumption that the commodity-exporter countries are unable or unwilling to adjust exchange rates and tackle inflation?

Consider the following thought experiment. Assume the world economy consists of two countries, US and THEM. US (not necessarily the United States) exhibits relatively slow growth, sluggish demand, a sizable output gap, low capacity utilisation, and is a net importer of commodities. In contrast, THEM (Truly Hot Emerging Markets...) is characterised by no labour market slack and a zero output gap. Most crucially, THEM produces and exports commodities, under a regime of limited exchange rate flexibility against US.

Under these assumptions, if US adopts an expansionary monetary policy to strengthen domestic growth, THEM mimics its policy stance to avoid currency appreciation. In other words, THEM maintains stable exchange rates but imports overheating from US and exports higher food and fuel prices. The resulting global inflation loop may systematically amplify the effects of US monetary policy on US headline inflation.

A policy conflict emerges. The favourite US scenario is one in which exchange rate appreciation in THEM in response to US stimulus reduces global overheating (but THEM bears all adjustment costs in terms of lower export growth and loss of market share). The favourite THEM scenario is such that the removal of monetary accommodation in US – without exchange rate adjustment – reduces global overheating (but US bears all adjustment costs in terms of a higher output gap). The prisoner's dilemma outcome is global overheating with no exchange rate flexibility. A cooperative outcome instead is one in which THEM's exchange rate appreciates and US adopts a less stimulative stance. The increase in THEM net imports generates demand for US goods without overheating the global economy and without upward pressures on commodity prices.

A quantitative illustration of the above scenarios is provided, *mutatis mutandis*, in a set of model-based simulations conducted at the IMF.[6] These simulations abstract from zero bound considerations (so that the "nominal interest rate" is an index of the effective monetary stance), there are no capital controls or trade barriers, and no sterilisation of capital inflows. The highlights from these simulations can be summarised as follows.

In a baseline scenario of transmission under fixed exchange rates, US lowers interest rate by 2.5% in response to a persistent contractionary shock to consumption and investment. This dampens the fall in US output, which goes 1.2% below potential in the year following the shock. THEM maintains a peg against US. Its interest rate falls in tandem with US, and output expands 4.5% above potential. Fast growth in the commodity-intensive THEM country exerts upward pressure on global oil and food prices (up 14% and 5.3% respectively). In the short run, US headline inflation is up 0.4% despite the US slowdown and the fall in US core inflation.

An alternative scenario considers transmission under flexible exchange rates. Now THEM follows an inflation targeting regime and increases its interest rate in response to the US cut in order to avoid overheating.

Relative to the baseline scenario, THEM output expansion is halved, and headline inflation rises by only half as much as under a peg, as oil prices increase by 9% rather than 14%. The effects on US output through reduced demand for exports are small. The effects on core inflation (through dollar depreciation) are also small. In sum, flexible exchange rates are good for US and good for THEM.

Suppose instead that THEM maintains a regime of limited exchange rate flexibility but US responds to both core and non-core price inflation, internalising THEM's lack of policy

[6] IMF (2008), Chapter 3, Box 3.3. The simulations use a five-region version of the IMF-BoC DSGE Global Economy Model, where their analog of the US country represents 21% of the world economy, their analog of the THEM country represents 25% of the world economy, and other three regional blocs make up for the rest of global output.

response and taking account of the effects of its monetary policy on the rest of the world. The US stance is now less accommodative, its interest rate falls 1.5% instead of 2.5% and rapidly goes 0.3% above neutral. The US output gap deteriorates 1.2% more than baseline. But the peak oil price falls to 4% from 14%. Inflation in THEM is much more stable than under the baseline scenario. The drawback is that, according to the simulations, core inflation falls a lot in US. Paradoxically, targeting headline rather than core prices makes headline inflation under headline targeting more volatile than headline inflation under the baseline scenario (as the entire US economy becomes more volatile)!

All these results can be summarised by suggesting that there is a case for core price targeting as best response to swings in commodity prices, although the case for core targeting is stronger in advanced economies than in emerging markets. There is also a (strong) case in favour of global exchange rate flexibility, and the jury is still out on whether there may be a second-best case for reacting to world inflation when inflexible exchange rate regimes represent a source of distortion in global commodity markets.

Appendix

In the model above, commodity price shocks were equivalent to shocks to the domestic price of imports. In contrast, suppose now that monetary policy may affect the domestic price of commodities through its effects on the exchange rate. Recalling the law of one price, we can think of P_F as the product of two components: the price of foreign exports in foreign currency, P_F^*, multiplied by the nominal exchange rate, $\mathcal{E}$.

Assume the equilibrium exchange rate $\mathcal{E}$ is function of the relative (domestic vs. ROW) monetary stance:

$$\mathcal{E} \propto \mu / \mu^*$$

and take the foreign monetary stance as given, so $\widehat{\mu^*} = 0$. Also, assume that in the short run, exchange rate pass-through to import prices may be less than full. Putting all these elements together, we can revisit our model under the new pricing behaviour:

$$\widehat{P_F} = \alpha^* \hat{\mu} + \widehat{P_F^*}$$

Now when μ falls the exchange rate appreciates, reducing the inflationary effects of commodity price hikes. A domestic monetary contraction directly reduces import prices in domestic currency terms and improves TOT.

Under core targeting we have:

$$\widehat{P_H} = \alpha\hat{\mu} = 0$$

$$\widehat{P_F^*} > 0$$

$$\hat{P} = (1-\gamma)\widehat{P_F^*} > 0$$

$$\hat{C} = -\hat{P} = -(1-\gamma)\widehat{P_F^*} < 0$$

$$\hat{Z} = (1-\gamma)(\widehat{P_H} - \widehat{P_F}) = -(1-\gamma)\widehat{P_F^*} < 0$$

$$\hat{\ell} = \hat{C} - \hat{Z} = -(1-\gamma)\widehat{P_F^*} + (1-\gamma)\widehat{P_F^*} = 0$$

In Figure 3, the economy moves from O to C.

Under headline targeting we have instead:

$$\hat{P} = \gamma\widehat{P_H} + (1-\gamma)\widehat{P_F} = 0$$

$$0 = \gamma\alpha\hat{\mu} + (1-\gamma)\left(\alpha^*\hat{\mu} + \widehat{P_F^*}\right) \Rightarrow$$

$$\hat{\mu} = -\frac{1-\gamma}{(1-\gamma)\alpha^* + \gamma\alpha}\widehat{P_F^*} < 0$$

$$\hat{C} = \hat{\mu} - \hat{P} = -\frac{1-\gamma}{(1-\gamma)\alpha^* + \gamma\alpha}\widehat{P_F^*} < 0$$

$$\hat{Z} = (1-\gamma)(\widehat{P_H} - \widehat{P_F}) = -\left[\frac{(1-\gamma)\alpha}{(1-\gamma)\alpha^* + \gamma\alpha}\right]\widehat{P_F^*} < 0$$

$$\hat{\ell} = \hat{C} - \hat{Z} = -\frac{(1-\gamma)(1-\alpha)}{(1-\gamma)\alpha^* + \gamma\alpha}\widehat{P_F^*} < 0$$

From a positive point of view, Figure 3 resembles Figure 2. The economy moves from O to H, consumption falls more under headline targeting than under core targeting, labour effort falls below full employment. But now it is no longer true that the terms of trade fall more under headline targeting than under core targeting. In fact, this depends on whether α is greater than α^* or not. If $\alpha^* < \alpha$ core targeting prevails in welfare terms (as before, when $\alpha^* = 0$). But if $\alpha^* > \alpha$, welfare is higher under headline targeting! In Figure 3, Z falls less under headline targeting than under core targeting. Even though consumption falls more under headline targeting than under core targeting, the terms of trade fall by less: workers in the exportable sector provide less labour effort and enjoy more leisure, more than compensating for the loss of consumption.

Figure 1

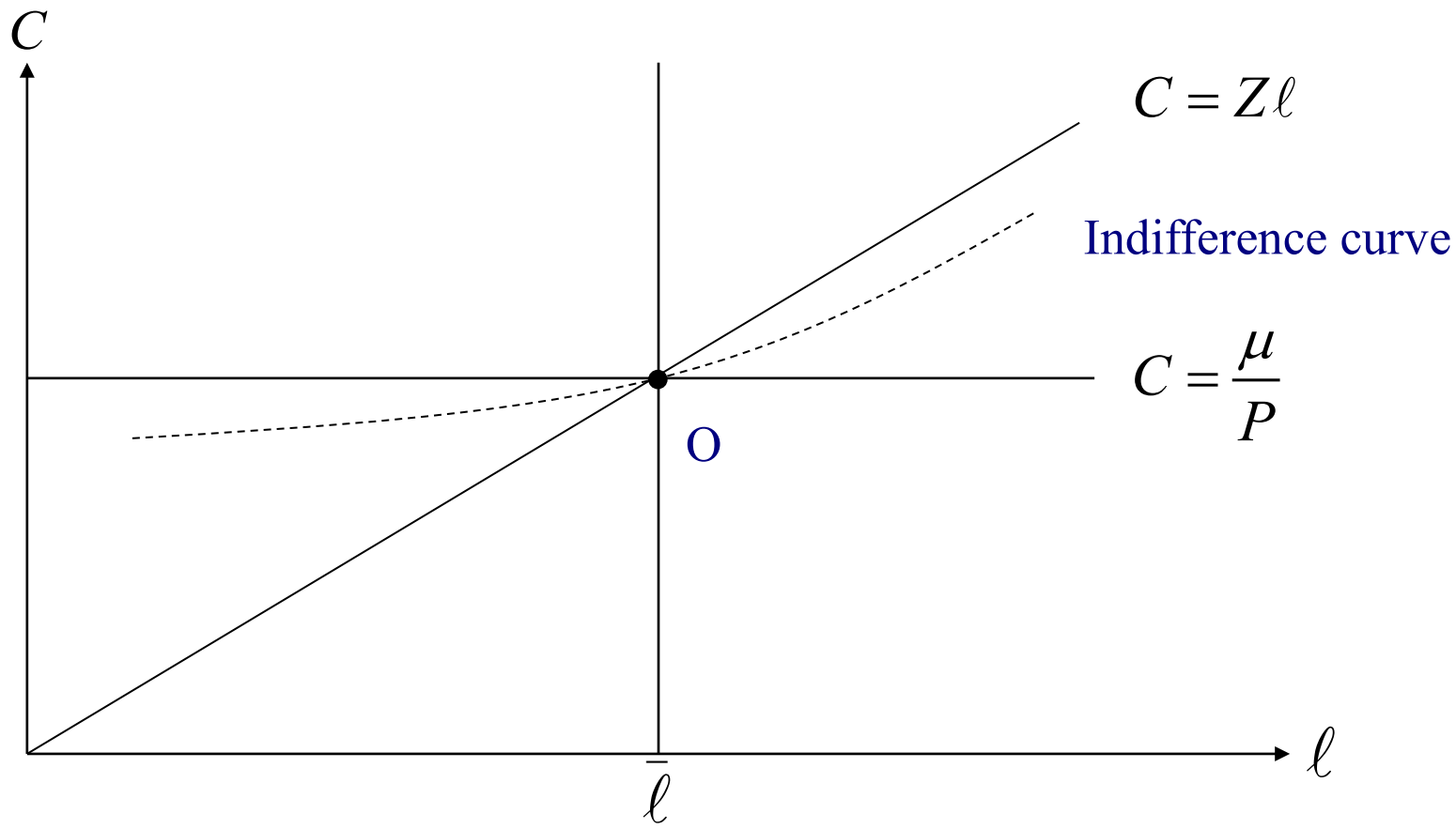


Figure 2

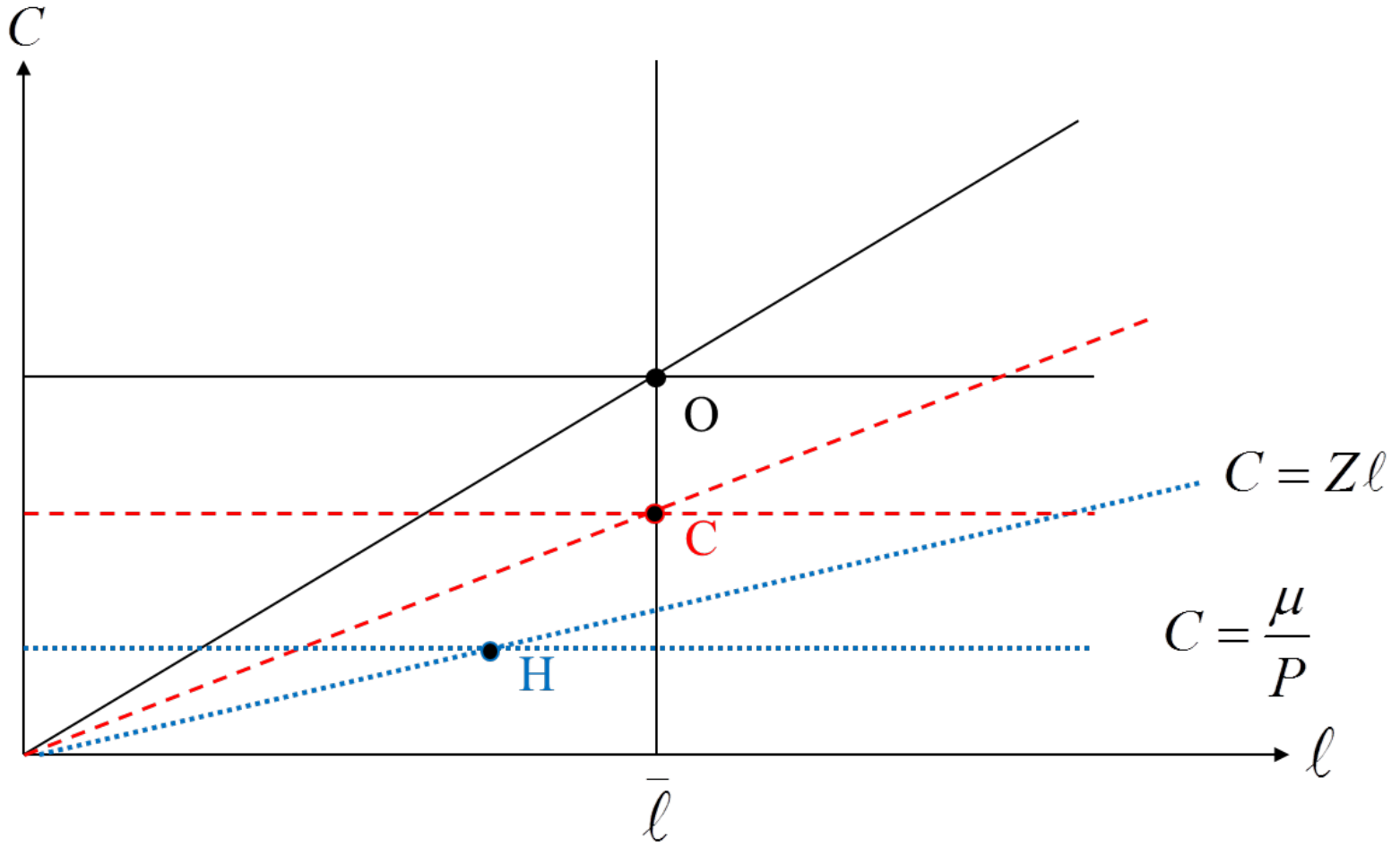
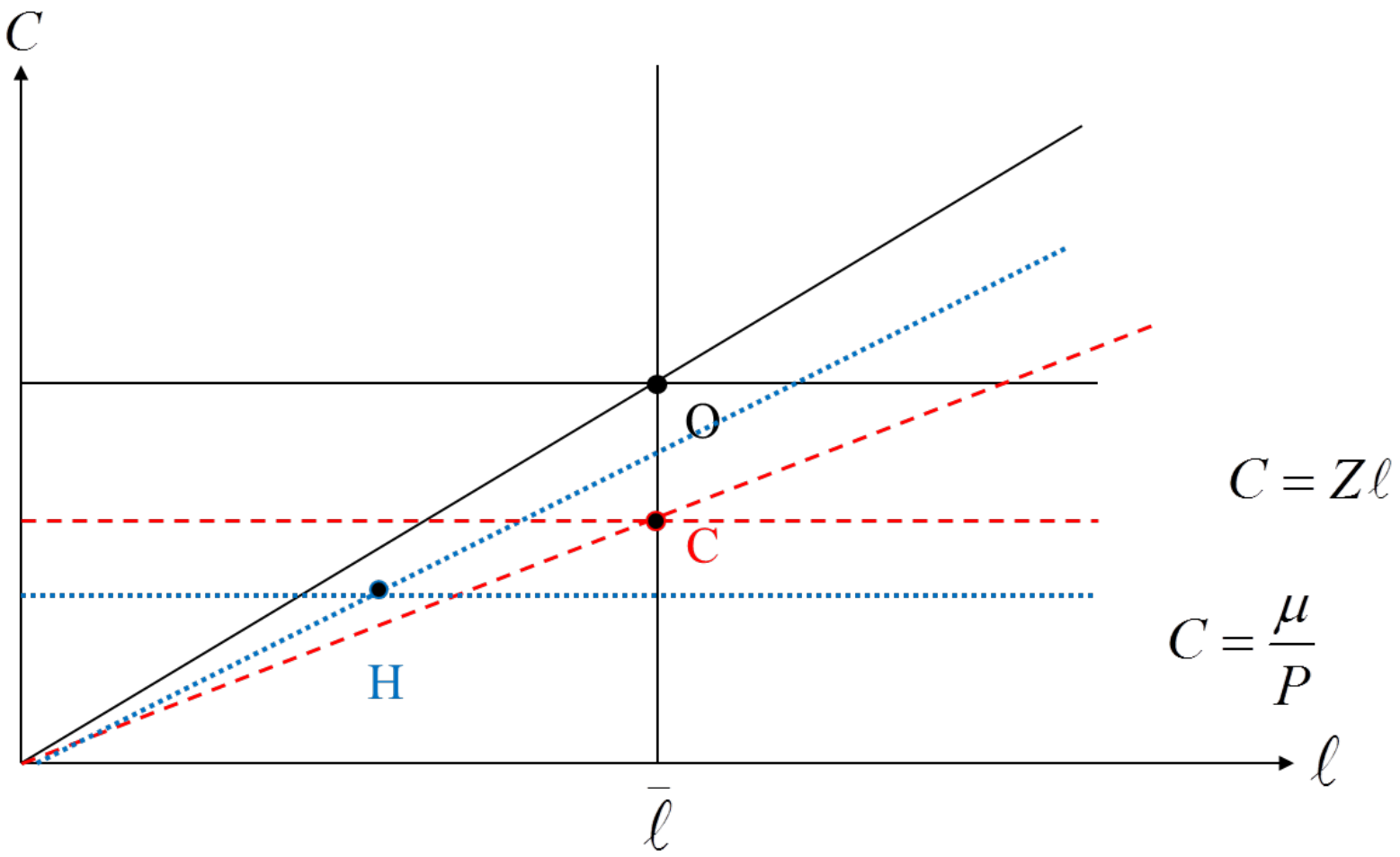


Figure 3



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